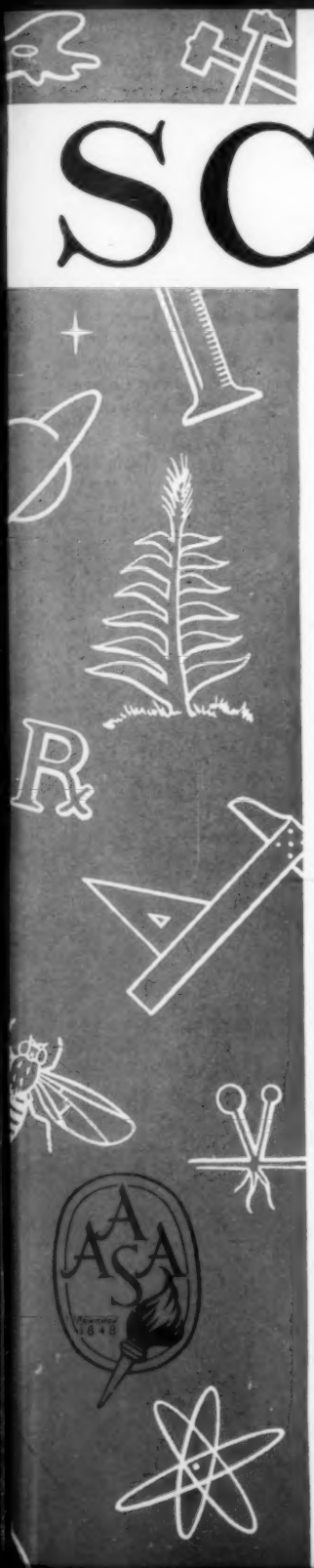

SCIENCE

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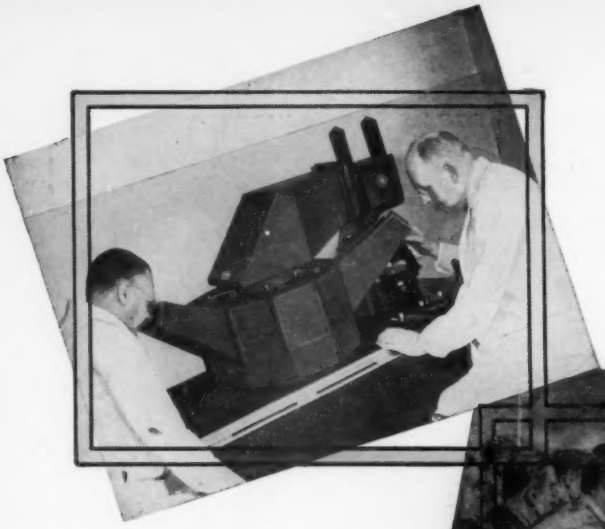

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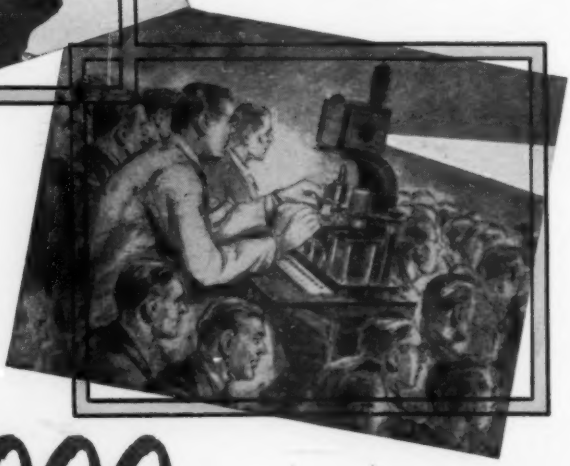

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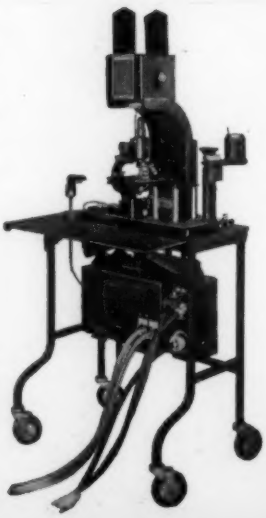

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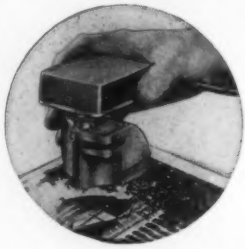

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Physics of the Atmosphere

THE earth's atmosphere has been examined closely only during the past several centuries. In 1714 Halley stated, "The theory of the air seems now to be perfectly well understood, and its different densities at all altitudes, both by reason and experiment, are sufficiently defined." At that time it had been concluded that the atmosphere was about 70 km in extent and that it became rarer and colder with increasing altitude. Dalton's treatise (1793) *On the Atmosphere; its Constitution, Figure, Height, etc.* criticized the twilight technique for determining the thickness of the atmosphere and determined a relationship (that is approximately correct up to the tropopause) for the temperature decrease with altitude. In 1749 kites were utilized to study the atmosphere above the surface; however, the use of free balloons languished until 1892. Subsequent balloon flights revealed the isothermal region which de Bort termed the "stratosphere." In 1880 Hartley correctly ascribed the absorption bands, which limit atmospheric transparency near 2950 A, to ozone. A study of geomagnetism permitted some of the earliest inferences regarding the electrical state of the high atmosphere. Gauss, in 1839, wrote that the "mysterious phenomena of the aurora . . . forbid us to deny outright the possibility of [electric] currents" in the high atmosphere. Stewart's work (1878), seeking to clarify geomagnetic variations by atmospheric events, was quantitatively extended by Schuster (1889). Marconi's transatlantic radio transmission led to Kennelly's and Heaviside's independent suggestion (1902) of the existence of the ionospheric layers, but experimental proof was lacking until 1925.

Below 100 km the temperature varies between 200° and 300° K, rising to a maximum of about 3900° K (summer) near 400 km. Molecular oxygen dissociates in the vicinity of 100 km or perhaps slightly higher, but the state of nitrogen is controversial; both oxygen and nitrogen, however, probably extend to the exosphere. Auroral observations suggest the presence of ionized molecular nitrogen to 1000 km. The diffusive separation of the atmospheric gases has been recognized to be a complex, three-dimensional problem of diffusion in a heterogeneous mixture having sources and sinks, and being further complicated by the presence of ions in a magnetic field. Large-scale wind circulation, turbulence, and tidal oscillations are found in the high atmosphere. The profound distortions of long-enduring meteor trains, indicative of violent motions in the altitude range 70–140 km, have long been known. Cloudlike patches, either of high electron density or of concentrated turbulence, exist near 100 km; these patches of sporadic E move rapidly at speeds of about 200 km/hr. Radio probings of each of the ionospheric layers indicate comparable speeds, with diurnal and seasonal variations.

The fascinating luminosities of the aurora are being coaxed not only to provide information with respect to atmospheric temperature and constituents, but also to yield data on the nature and energy of the particles (presumably of solar origin) bombarding the earth's atmosphere. Meinel's remarkable observations, already confirmed, demonstrated that protons entering the atmosphere at speeds of 10^8 cm/sec accompany some types of auroral displays.

Notwithstanding the progress already made, research on the high atmosphere is still in its infancy. Much work remains to be done on cross sections for collision and energy absorption, on the origin of magnetic variations, on the formation of the aurora, on the constituents present, on innumerable photochemical reactions possible, etc. Knowledge of these factors will enable us better to predict the changes to be expected in the high atmospheric regions.

N. C. GERSON

Geophysics Research Division
AF Cambridge Research Center

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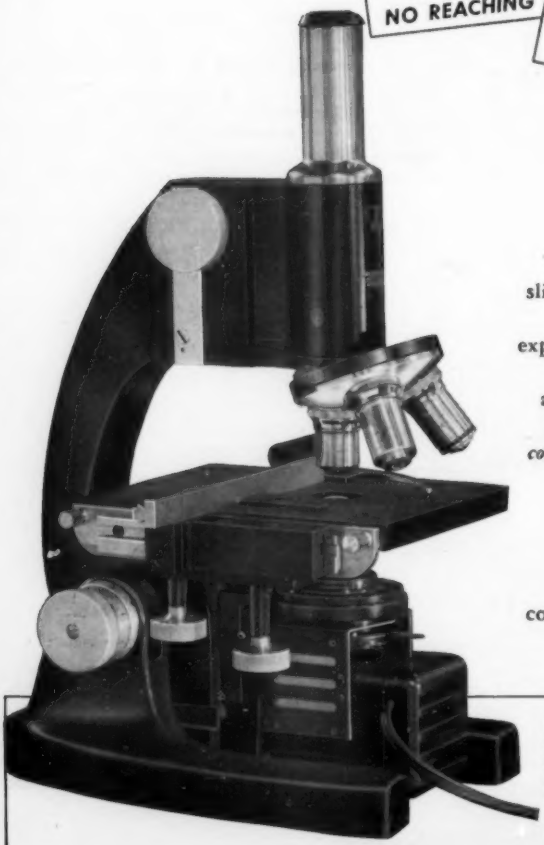

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Composition of Honeydew Excreted by Pineapple Mealybugs[1]

Reed A. Gray[2]

Pineapple Research Institute of Hawaii, Honolulu

THE EXCRETION OF THE PLANT-SUCKING INSECTS, aphids and coccids, is a clear, syrupy liquid and contains much unabsorbed organic material. This honeydew contains a high percentage of sugars and is much sought after as food by ants and other insects. In some cases, the excreted liquid, on drying, leaves a white deposit on the leaves. Manna is such an excretion from the coccid *Trabutina mannipara* feeding on tamarisk in Sinai, and according to Weber (*1*) it contains 55 per cent cane sugar, 25 per cent invert sugar, and 19.3 per cent dextrin, making a total of 99.3 per cent carbohydrates.

The reason for this apparently wasteful method of feeding is generally thought to be a deficiency of organic nitrogenous compounds in the plant juice. The insect must therefore take in large quantities of plant juice in order to get sufficient amino acids and proteins, with the result that it has a large excess of carbohydrates to dispose of (*2*). In the work reported here, this was not found to be the case with pineapple mealybugs (*Pseudococcus brevipes* Ckll.), since large quantities of free amino acids were found to be present in their honeydew, as well as large quantities of sugars.

The pineapple mealybug is the well-known insect that has been shown by Carter (*3*) to be responsible for "mealybug wilt" of pineapples, a unique, systemic disease that seems to be due to a nonreproducing toxin secreted by the mealybugs. Our work came about as a by-product of studies in which the salivary secretions of mealybugs were being examined for toxins. In some of the experiments, mealybugs were allowed to feed through a membrane into a nutrient medium, and it became apparent that the salivary secretions might be contaminated with the honeydew excreted by the bugs. Therefore, an examination of the constituents of the honeydew was undertaken.

One- and two-dimensional filter paper chromatograms were prepared, using the ascending method described by Williams and Kirby (*4*). The solvent for the one-dimensional chromatograms was fresh *n*-butanol-acetic acid-water (4:1:1 v/v). For the two-dimensional chromatograms, honeydew was collected with a capillary, diluted 1:5 with water in most cases, and 4 µl of this solution was applied in the corner, 3 cm from each edge, on a sheet of Whatman No. 1 filter paper (11″×14″). Phenol-water (8:2 w/w) was used as the first solvent and *n*-butanol-acetic acid-water (4:1:1 v/v) as the second; this solvent combination seemed to be very satisfactory because of its versatility in separating different types of compounds. After drying at room temperature, the chromatograms were dried at 60° C for an hour and then sprayed with the appropriate reagent. It was found that several different types of compounds could be detected on the same chromatogram by using successive reagents.

To detect amino compounds, after drying the chromatograms were sprayed with 0.25 per cent ninhydrin in *n*-butanol saturated with water (*4*), and heated 20 minutes at 80° C. To detect sugars, dried chromatograms were sprayed with 1 per cent potassium permanganate in 2 per cent aqueous sodium carbonate (*5*). This spray could be applied after ninhydrin, and the sugars appeared as yellow spots. Sugars were also identified with the benzidine-trichloroacetic reagent (*6*), which could also be applied with some usefulness after the paper had already been treated for amino acids.

A new reagent was found to be specific in differentiating ketoses from aldoses. The paper is sprayed with a saturated solution of 2,4-dinitrophenylhydrazine in 95 per cent ethanol containing 1 per cent concentrated HCl, and heated a few minutes at 70° C. This spray gives an orange spot on a light-yellow background for fructose and compounds containing fructose, such as sucrose, raffinose, and fructose-6-phosphate. Other sugars do not give any color that can be distinguished from the light-yellow background. As little as 3 µg of fructose can be detected by this method after chromatographing with the butanol-acetic acid solvent.

Malic acid, citric acid, and partially neutralized citric acid were detected with 0.1 per cent bromocresol-green in 95 per cent ethanol (*7*). Citric acid appears yellow, and disodium citrate forms two spots, one yellow and one blue, when phenol is the developing solvent. It was found that partially neutralized citric acid formed four spots when chromatographed in two dimensions with the solvents described above.

A pineapple leaf, 18 inches long, was made radioactive by allowing it to photosynthesize for 24 hours in an atmosphere containing $C^{14}O_2$, similar to the method described by Calvin (*8*). The capacity of the

[1] Published with the approval of the Director as Technical Paper No. 202 of the Pineapple Research Institute of Hawaii.

[2] The author is indebted to Willis A. Gortner and Walter Carter, heads of the Departments of Chemistry and Entomology of the Pineapple Research Institute of Hawaii, for their encouragement and suggestions pertaining to this work.

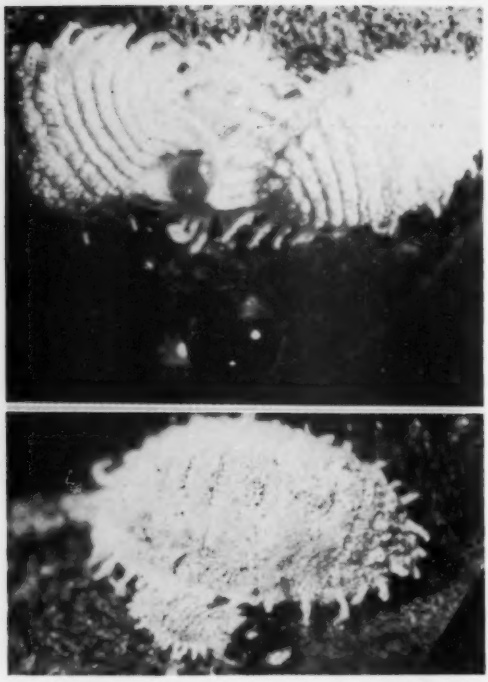

FIG. 1. Pineapple mealybugs (*Pseudococcus brevipes*, Cockerell) feeding on immature pineapple fruit and showing the clear globules of excreted honeydew.

photosynthetic chamber was 900 ml, and 900 mg $BaCO_3$[3] containing 0.5 mc C^{14} were used.

The radiograms were prepared by placing the developed chromatograms in close contact with Eastman No-Screen X-Ray film for 7 days, as described by Benson *et al.* (*9*). The radioactivity of the spots was determined by using a Geiger tube (1.75 mg/cm² mica window) placed on a 4-mm-thick plastic spacer with a hole in it, 1 inch in diameter. A smaller hole, 1 cm in diameter, in the same plastic sheet was used for localizing smaller spots on one-dimensional strips.

Preliminary experiments. Pineapple mealybugs excrete small droplets of a perfectly clear colorless fluid (Fig. 1). Under normal conditions the mealybugs are attended by ants, which eagerly seek the honeydew, but if the ants are kept away the excretions sometimes accumulate as droplets on the backs of the mealybugs near the posterior end. Honeydew is excreted from the anus and must not be confused with secretions from several different types of glands, such as wax or a liquid which is extruded from several pores when the bug is touched, and which solidifies quickly.

A few of the honeydew droplets were gathered with a capillary from the backs of several bugs and chromatographed in one dimension. One strip showed four well-defined spots of sugars with the permanganate spray. Two of the spots were identified as fructose and sucrose with the new spray test described above. The other sugars were identified later by using two-dimensional paper chromatograms and radioautography. One strip was sprayed with ninhydrin for amino acids. Since it was expected to find only sugars in the honeydew, it was a great surprise to find 12 amino-acid spots appearing on the paper strip.

Carbohydrate and other radioactive compounds. In the second experiment, medium-sized mealybugs were removed from green pineapple fruit, starved one day, and then caged on a pineapple leaf that had photosynthesized in an atmosphere containing $C^{14}O_2$ for 24 hours. After the bugs had fed on the radioactive leaf for 48 hours, some of their clear honeydew excreta had collected on the clean plastic top of the cage opposite the bugs. It was observed later that the mealybugs were able to squirt out tiny droplets of this honeydew with enough force to carry it upward for a distance of 5 mm, where it adhered to the top of the cage. The honeydew was collected, chromatographed in two dimensions, and sprayed with ninhydrin. Only 3 amino acids appeared; they were identified as cystine, aspartic acid, and glutamic acid from their R_f values and their relative positions as obtained from chromatograms of artificial mixtures of pure amino acids. The same chromatogram was sprayed on the reverse side with alkaline permanganate. The three distinct yellow spots that appeared were identified as sucrose, glucose, and fructose. A radioautograph was made with the same chromatogram (Fig. 2). The radioactivity of each spot is given in Table 1.

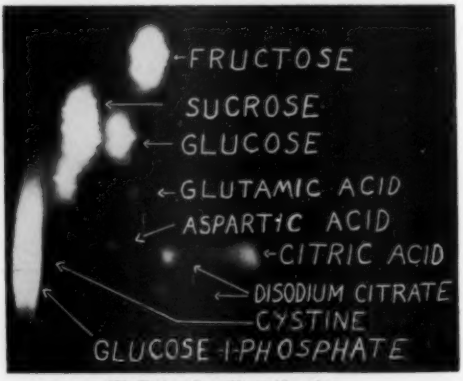

FIG. 2. Radiogram of honeydew excreted by pineapple mealybugs while feeding for 48 hr on a radioactive pineapple leaf. The leaf had photosynthesized in an atmosphere containing $C^{14}O_2$ for 24 hr.

The purpose of the radioactive carbon was to detect small amounts of material or those not easily detected by the usual tests. The elongated spot that did not move in the butanol-acetic solvent was not readily identified by the various chemical sprays. The lower,

[3] The $BaC^{14}O_3$ was purchased from the Oak Ridge National Laboratories on allocation from the Isotopes Division, U. S. Atomic Energy Commission.

TABLE 1

RADIOACTIVITY OF SPOTS SHOWN IN FIG. 2

Spot	cpm	Spot	cpm
Fructose	2524	Cystine	Not determined
Glucose	776	Aspartic acid	74
Sucrose	2836	Glutamic acid	60
Glucose-1-phosphate	3420	Citric acid	261

more intense part (*arrow*) gave a positive test for phosphates (*9*) and is the position that pure glucose-1-phosphate occupies when run in two dimensions in these solvents. It was not established that the entire spot was glucose-1-phosphate (the upper half of the spot was probably dextrins), but proof that this elongated spot contained glucose and phosphate was obtained as follows:

Several one-dimensional chromatograms of the radioactive honeydew were run in the *n*-butanol-acetic acid-water solvent. One strip was sprayed for phosphate (*9*), and two blue spots containing phosphate appeared—one at the origin and the other at R_f 0.19. The latter spot was not radioactive and thus did not show up in the radiogram. The spot at the origin of another strip was cut out and eluted with hot water. After concentration, this material was partially hydrolyzed by heating for a few minutes in 2 *N* HCl and then evaporating the water and acid. The residue was taken up with a few drops of sugar solution containing fructose, glucose, and sucrose as carriers. The resulting solution was then chromatographed with the same solvent, and the sugar spots were located with the permanganate spray. The spots were counted as before, except that the small hole, 1 cm in diameter, was placed over the spots. The counts for one minute for each spot after correction for background were: fructose, 8; sucrose, 12; and glucose, 168. This shows that only glucose is produced on hydrolysis; however, over half the activity remained near the origin, since it probably was not completely hydrolyzed.

The citric-acid and disodium-citrate spots were located with indicator, and the reagent could be applied after treating the paper with ninhydrin. The spot just below sucrose in Fig. 2 was not identified, but its R_f values correspond with maltose. The concentration was evidently too low to be chemically identified. Two black spots were formed with mercuric nitrate reagent (*10*) for purines and pyrimidines, but one of the spots coincided with cystine, and the other was very near aspartic acid.

It was rather puzzling to find 12 amino acids in the honeydew in the first experiment and only 3 in the second. After the mealybugs had fed 4 days on the radioactive leaf, the honeydew was again collected and chromatographed. It was then found to contain 7 amino compounds (cystine, aspartic acid, glutamic acid, serine, asparagine, glutamine, and one unidentified spot). All amino compounds that were not masked by sugars contained some radioactive carbon. Malic acid was also found in the 4-day excretion by indicator sprays and a radioautogram.

Amino components and their increase with feeding period. It appeared that the longer the period of feeding by the mealybugs, the more numerous the amino acids excreted in the honeydew. This view was substantiated by a third experiment carried out on a much larger scale. Two hundred mealybugs were caged on each of 20 leaves from different pineapple plants. The cages were removed, the excretions collected, and new, clean cages put on at regular intervals of 24 hours for the first 4 days, and then intervals of 48 hours for the next 6 days. The excretions were chromatographed in fresh *n*-butanol-acetic acid solvent for 40 hours, dried, and sprayed with ninhydrin. The average number of amino acids that appeared in the one-dimensional chromatograms for each sample of bugs that produced enough honeydew to collect is shown in Table 2, along

TABLE 2

RELATION OF MEALYBUGS' FEEDING PERIOD TO NUMBER OF AMINO ACIDS FOUND IN THEIR EXCRETION

Period of mealybug feeding (days)	1	2	3	4	6	8	10
No. samples	15	17	14	9	12	7	2
Av no. amino acids/sample in excretion	4.0	7.3	8.4	9.8	11.3	12.0	13.0
Standard error	0.62	0.56	0.89	0.62	0.80	0.57	0

with the number of replicates and the standard error. The results show conclusively that the number of amino acids excreted in the honeydew increases with the period of feeding of the bugs up to about 10 days. After 10 days no further increases were noticed in the one-dimensional chromatograms. As the period of feeding increased, the amount of excretion decreased, and after 10 days only two of the lots of bugs excreted enough honeydew to collect. After 6 or 8 days, one tenth the amount of honeydew (diluted 1:10) gave a higher concentration of amino acids (based on intensity and size of the spots on the chromatogram) than the undiluted honeydew collected during the first few days. Differences in composition were noted which could have been due to differences in the mealybugs or the leaves, or starvation from the time they were removed from the green fruit until they were put on the leaves. For instance, after 24 hours' feeding and using the same volume of honeydew, three samples contained only 1 amino acid, whereas several samples contained 7 amino acids in each. The two-dimensional chromatograms of Fig. 3 show the differences between two samples collected after feeding 1 day and then again during the 8–10-day feeding period. Fig. 3 also illustrates the increase in number of amino acids with the increase in feeding time.

Source of the amino acids. Where do the amino acids found in the honeydew excreted by the mealybugs come from? That this increase of amino acids was not due to nitrogen fixation outside the mealybugs was shown by allowing an aliquot of honeydew to

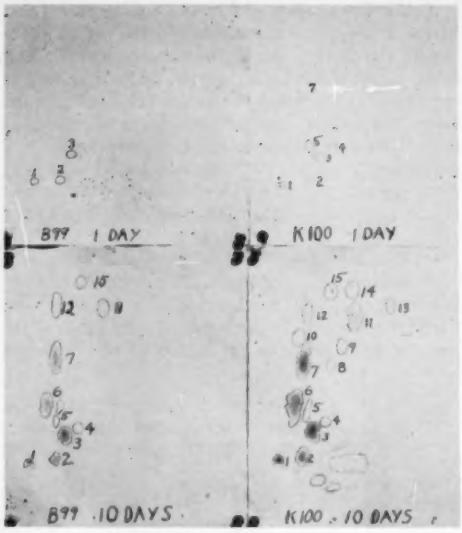

FIG. 3. Two-dimensional filter paper chromatograms of honeydew excreted by two lots of mealybugs feeding on two different leaves, and showing increase in number and amount of amino acids with time of feeding The two samples of honeydew for the upper chromatograms were collected after the mealybugs had fed on the leaves for 1 day; honeydew for the lower chromatograms was collected from the same two lots of bugs during an 8–10-day period on the same leaves. Spots outlined with tangential lines were fluorescent in ultraviolet light. The compounds reacting with ninhydrin are outlined in pencil and indicated by numbers; the spots that have been identified are: (1) cystine, (2) aspartic acid, (3) glutamic acid, (5) serine and glycine, (6) asparagine, (7) glutamine, (8) alanine, (9) tyrosine, (10) histidine, (11) tryptophane, (13) phenylalanine, and (15) proline.

stand 3 days, and comparing it with the fresh honeydew. No increase in amino acids was noticed. Also, in some cases, the excretion was removed from the backs of several mealybugs shortly after it was excreted, and it still contained as many as 12 amino acids. It cannot be said that the amino acids come entirely from unabsorbed amino acids in the plant juices, since 6 or 7 of the amino acids that appear in the honeydew do not appear in the juice pressed from frozen pineapple leaves on which the mealybugs fed. This was shown by an experiment in which the honeydew collected from mealybugs during the 8–10-day period on a pineapple leaf was compared chromatographically with the juice pressed from the same leaf after freezing and thawing it. The excretion of mealybugs feeding on a small green pineapple fruit was also compared with the juice of the same fruit. These chromatographs are shown in Fig. 4.

It can be seen from Fig. 4 that 7 amino acids appeared in the honeydew that did not appear as free amino acids in the leaf juice; these spots are marked with the letters *A–G*. One of the most striking of these was proline (spot *G*), which gives the characteristic yellow color with ninhydrin. Not all these 7 amino acids were found in bound form in the proteins of the leaf juice. This was shown on an aliquot of the same juice as used in chromatograph No. 1 of Fig. 4, by precipitating the proteins with 10 per cent trichloroacetic acid, and hydrolyzing the precipitate in 6 *N* HCl for 24 hours at 105°–110° C in a sealed tube. The acid was removed by evaporating in a vacuum desiccator over solid NaOH, adding water, and repeating the evaporation several times. After applying the hydrolysate to the paper, the spots were treated with NH_3 vapor, dried, and chromatographed in two dimensions. The amino acids in the proteins of the juice were thus compared with the free amino acids in the juice. Spots *F* and *G* were found in small amounts in the protein hydrolysate, leaving 5 spots (*A, B, C, D,* and *E*) which were found in the honeydew but not in the juice or in the hydrolyzed proteins of the juice.

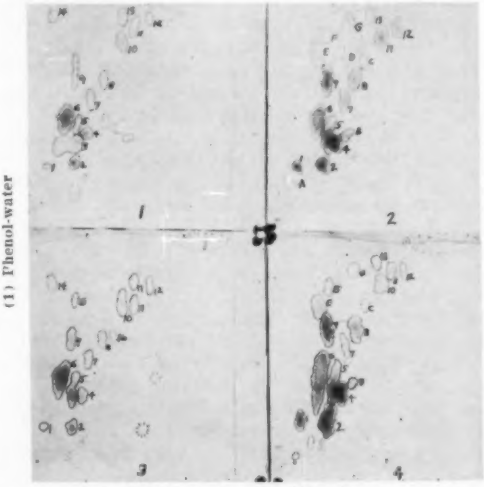

FIG. 4. Two-dimensional filter paper chromatographs sprayed with ninhydrin and showing the difference in composition between (1) juice of pineapple leaf fed on by mealybugs for 10 days, and (2) honeydew excreted by mealybugs during the 8–10-day feeding period on the same leaf, and also the difference in composition between (3) juice of a green pineapple fruit and (4) honeydew from mealybugs fed on the same fruit. Compounds reacting with ninhydrin appear as dark spots in the photograph and are outlined in pencil. Tangential lines mark spots that fluoresced in ultraviolet light. The spots that have been identified are: (1) cystine, (2) aspartic acid, (3) glutathione, (4) glutamic acid, (5) serine (lower half of spot) and glycine (upper half), (6) asparagine, (7) threonine, (8) alanine, (9) glutamine, (10) tryptophane, (11) valine, (12) phenylalanine, (*C*) tyrosine, (*E*) histidine, and (*G*) proline.

From Fig. 4 it can be seen that several amino acid spots appeared in the pineapple leaf which did not appear in the honeydew; they are spots 3, 10, and 14. Spot 3 was identified as glutathione. Similar results were observed with the honeydew from bugs feeding on the green fruits and the juice of the fruits. Usually more amino acids were found in the excreta of mealybugs feeding on pineapple leaves than in the excreta of those feeding on pineapple fruit. Numerous amino

acids were also found in the honeydew excreted by mealybugs feeding on yucca leaves.

Some of the amino acids found in the honeydew excreted by the mealybugs are evidently unabsorbed amino acids from the plant juices, as are some of the main sugar components. The presence of sucrose indicates a lack of invertase activity in the intestinal tract. The fact that the 3 amino acids excreted by mealybugs feeding on a radioactive leaf contained C^{14} does not mean incontestably that they were unabsorbed amino acids from the juice, but one would think they were.

The amino acids present in the excretion but not in the food source could be metabolic waste products for nitrogen excretion by the mealybugs, or they could be produced by symbionts within the insects. Toth, Walsky, and Batori (*11*) have reported nitrogen fixation by macerated aphids in a solution of oxalacetic acid and glucose. The possibility that nitrogen fixation occurs in mealybugs is being investigated. An experiment was carried out in which 1000 mealybugs were fed for one week on agar containing 0.1 per cent oxyquinoline benzoate, a powerful fungicide and moderate bactericide. The mealybugs were then transferred to pineapple leaves and their excreta collected. As before, many amino acids were found in the honeydew. Evidently, the antiseptic did not impair the mealybugs' ability to excrete amino acids in their honeydew. Symbionts of several forms have been found enclosed within the mycetomes of two strains of pineapple mealybug by Carter (*12*), and a relationship might be found between the form (species) of symbionts present and the different amino acids found in the excretion of the bugs.

The increase of amino acids in the honeydew with the increase in feeding period by the mealybugs may have some relationship to their ability to produce wilt in pineapples, since an increase in toxicity of the mealybugs with an increase in feeding period has been found to occur (*13*). The toxicity of the mealybugs is also governed by the nutrition of the insect (*14*).

The presence of these important nutrients in the honeydew certainly seems to be a wasteful method of feeding, but it may be necessary for the mealybugs to suck in excessive quantities of juice in order to get sufficient quantities of other substances that occur in very small amounts. These findings tend to confirm the theory that the availability of these excretions as food for ants has undoubtedly been a factor in the evolution of the close relationship between these two groups of insects.

The general view that plant-sucking insects, which excrete copious quantities of excess carbohydrates in their honeydew, must take in large amounts of plant juice in order to get sufficient amounts of amino acids and proteins, was not found to be the case with pineapple mealybugs. Relatively large amounts of as many as 19 different amino acids and amides have been found in the honeydew excreted by pineapple mealybugs (*Pseudococcus brevipes*, Ckll.) by the method of paper chromatography. The number of amino acids excreted was shown to increase with the period of feeding. The 16 amino components of the honeydew that have been identified from their R_f values are cystine, aspartic acid, glutamic acid, serine, glycine, asparagine, threonine, alanine, glutamine, tryptophane, valine, phenylalanine, histidine, and proline. Three ninhydrin spots have not been identified. At least 5 amino acids were found in the honeydew which were not found in the food source.

The carbohydrate components identified by different sprays and radiograms of radioactive honeydew were fructose, glucose, sucrose, glucose-1-phosphate, and possibly maltose. Malic acid, citric acid, and salts of citric acid were also found.

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News and Notes

Scientists in the News

Franklin Institute's Hollingshead N. Taylor Memorial Award for 1951 was given to **Dick Adams,** formerly of Madisonville, Ky., but for several years past a patient at Temple University Hospital. The Taylor Award, established in 1938, is presented annually to a young man between the ages of 18 and 22, to assist in defraying expenses of flight instruction, aviation ground school, or instrument flight training. It was founded by Mrs. Taylor, of Anselma, Pa., in memory of her husband, a pioneer in the field of aviation and past president of the Aero Club of Pennsylvania, which is custodian of the fund.

J. Burns Amberson, visiting physician in charge of the chest service of Bellevue Hospital, will give one of three scientific papers at the twelfth conference of the International Union against Tuberculosis, to be held in Rio de Janeiro Aug. 24–27. Dr. Amberson will present the principal report on "Treatment and Prognosis in Minimal Pulmonary Tuberculosis." Other papers will be on "Immunity and Tuberculosis," with **Arvid Wallgren,** of Sweden, as the principal speaker, and "Organization and Results in Regard to the Tuberculosis Campaign of Mass Surveys," with **Fernando Gomez,** of Uruguay, as chief reporter. **Manoel de Abreu,** of Rio de Janeiro, president of the union, will preside at the conference, the first since the Copenhagen conference in 1950.

Geoffrey Beale, of the Institute of Animal Genetics, University of Edinburgh, will join **T. M. Sonneborn** at Indiana University, to work on a program of research in heredity. Dr. Beale worked during 1947–48 as a Rockefeller fellow in Dr. Sonneborn's laboratory and has since done similar research in Edinburgh.

William Beebe and the staff of the Department of Tropical Research of the New York Zoological Society sailed for Trinidad on Jan. 14, to take up residence for about five months at the department's laboratory in the Arima Valley. This is the fiftieth expedition of the department. Main objectives are completion of a preliminary report on the ecology of Arima Valley, comparative studies of social behavior in butterflies, and defensive behavior in mantids. Work on the analysis of insect color patterns and the ecology of caves will be continued.

Henry K. Beecher, Dorr professor of research in anaesthesia at Harvard Medical School, has been made a Chevalier of the Legion of Honor, by decree of the President of France.

Martin E. Brigham, who recently completed the requirements for the Ph.D. degree at the University of Michigan, has been appointed an instructor in geography at Ohio State University. He succeeds **Dee R. Eberhart,** who has accepted a position in the East Tennessee State College at Johnson City.

N. H. Ceaglske, professor of chemical engineering at the University of Minnesota, will join the staff of the Department of Mechanical Engineering at Case Institute of Technology as visiting professor of instrumentation. Dr. Ceaglske will be at Case during the second semester of the current academic year that began Feb. 4. He is on leave of absence from his professorship at Minnesota.

Ralph W. Chaney, professor of paleontology at the University of California, has recently returned from Japan, where he spent his sabbatical leave under the auspices of the American Philosophical Society and the Carnegie Institution of Washington. His work involved detailed museum and field studies of Tertiary floras, which were supplemented by lectures and research conferences at several universities in Japan, and at the Birbal Sahni Institute of Paleobotany, Lucknow, India.

Barnett Cohen, of Johns Hopkins, has retired as editor of *Bacteriological Reviews,* a technical journal published by the Society of American Bacteriologists, after serving since 1937. He has been succeeded by **Perry Wilson,** professor of bacteriology at the University of Wisconsin.

John G. Dean is now a chemical research consultant with headquarters at Tuckahoe, N. Y. He was formerly with the International Nickel Co., in charge of the Industrial Chemicals Section, Development and Research Division.

Howard Florey, professor of pathology at the University of Oxford, and **Ian Heilbron,** director of the Brewing Industry Research Foundation, have been awarded Royal Medals by the Council of the Royal Society of Great Britain, the former for his work on antibiotics and the latter for his work on vitamin A and polyene synthesis.

Thomas R. P. Gibb, Jr., has been appointed to the newly created position of director of sponsored research in chemistry at Tufts College. Dr. Gibb has been on the MIT faculty and later spent five years as an industrial research director. He is chairman-elect of the Northeastern Section of the American Chemical Society.

Carl G. Hartman has been made associate director of the Ortho Research Foundation, Raritan, N. J. **N. Millman** succeeds Dr. Hartman as director of the Division of Physiology and Pharmacology.

K. C. Heald, vice president of the Gulf Oil Corporation, Pittsburgh, will receive the Sidney Powers Memorial Medal of the American Association of Petroleum Geologists at its annual meeting Mar. 25 in Los Angeles "in recognition of his long and outstanding service and contributions in petroleum geology, and for his leadership in research bearing on the important problem of the origin of oil."

Margaret A. Losty has been named director of the new division of nursing services by the National Foundation for Infantile Paralysis. Miss Losty will serve as a consultant and in a liaison capacity between the foundation and other organizations concerned with providing poliomyelitis nursing services.

Donald M. Morrison has succeeded **O. B. Hopkins** as head of the Petroleum Division of the Canadian government, which has been responsible for Canada's extensive program of exploration, pipeline installation, and refinery development. Dr. Hopkins was loaned to the Canadian government by Imperial Oil Limited. Dr. Morrison, who was deputy director of the division, is on loan from the Shell Oil Co.

John Ryer Poppen, Medical Corps, USN, has retired from active Navy duty. He has been serving as director of the Navy's newest Aviation Medical Acceleration Laboratory located at the Naval Air Development Center, Johnsville, Bucks Co., Pa., since November 1949. Captain Poppen first entered the Naval service in 1917 as a coal passer.

Virgil P. Quirk has been appointed instructor in mineral technology extension of Pennsylvania State's School of Mineral Industries. He has recently been employed as a ceramic engineer for the Owensboro (Ky.) Sewer Pipe Company.

Herman E. Ries, Jr., has been appointed research associate in the Whiting Research Laboratories of Standard Oil Company (Indiana). Dr. Ries has been associated with the Sinclair Refining Company for the past fifteen years.

The following persons from abroad were recent visitors at the Eastern Regional Research Laboratory of the Agricultural Research Administration, Philadelphia: **Arturo Roque,** director, Agricultural Experiment Station, Rio Piédras, Puerto Rico; **M. H. Myklebust,** Valldal, Norway; **Renato Allegrina,** S. A. Leologu Milano, Milan; and **M. Suwarto, A. H. Siregar Moedahar,** and **P. Soedibio,** of the Ministry of Economic Affairs, Indonesia.

Herbert P. Sarett has been appointed chief of the Nutritional Research Division, Mead Johnson Research Laboratories. Dr. Sarett was formerly associate professor of biochemistry and medicine at Tulane.

After 37 years of service, **R. R. Spencer** has retired from the Commissioned Corps of the Public Health Service. Dr. Spencer's career with the Public Health Service has been marked by many achievements, probably the most notable being his part in the development, with the late **R. R. Parker,** of a vaccine against Rocky Mountain spotted fever in 1922. More than a third of Dr. Spencer's career has been devoted to work in the field of cancer. Detailed to the National Cancer Institute soon after its creation in 1937, he served from 1943 to 1947 as its director. Dr. Spencer has accepted an appointment as a special lecturer in cancer to conduct seminars for physicians throughout the state of Virginia under the joint sponsorship of the State Medical Society, the Old Dominion Medical Society, the Virginia Division of the American Cancer Society, and the University of Virginia. He assumed his new duties on Feb. 1, but is spending six weeks in New York City visiting cancer clinics and hospitals to observe the practical application of the newest developments in cancer diagnosis and treatment.

James Thorp, of the Division of Soil Survey, USDA, has accepted appointment as professor of geology and soils at Earlham College, Richmond, Ind. He will devote about half-time to teaching geology and soils, and half-time to the soil research program in the new Agricultural Science Department of the college. During the summer months he will be employed in research for the Division of Soil Survey.

Robert Watson-Watt, president of the Royal Meteorological Association and of the Institute of Navigation, will receive £50,000, tax-free, from the British government for his work in the development of radar before and during World War II. Sir Robert's prize is the largest since the award of £100,000 to Frank Whittle in 1948 for the invention of the jet engine.

Education

The **Institute of Marine Science,** Port Aransas, a relatively new branch of the University of Texas, has recently established three courses. The general introductory course in marine science is given in the first semester of the long session, and marine fishery biology and problems courses are given during the summer for graduates only. The institute is situated on Mustang Island, off the south Texas coast, on the pass connecting a large bay system and the Gulf of Mexico. A dock laboratory over the water, an onshore laboratory, and a forty-foot launch are used. Quarters with cooking facilities are provided free for students and visiting investigators. For additional information write the acting director, Port Aransas.

At **Johns Hopkins Hospital,** Richard H. Follis, Jr., Edwards A. Park, and Deborah Jackson are studying the bones of a consecutive series of 1303 white and Negro children autopsied at the Harriet Lane Home of the hospital between 1926 and 1942. In the one-day to two-year-old children they have found an incidence of scurvy more than 11.5 times as great as had been shown for this group by ordinary methods of clinical diagnosis. Their work is part of a larger analysis, still under way, of the effects of specific and nonspecific factors on skeletal tissue.

The **University of Kansas** has installed a color television system for under- and postgraduate medical instruction in its Medical Center in Kansas City, Kan. Three direct-view receivers in as many rooms will accommodate audiences of up to 40 at each point. The sound system is two-way, so that students may ask questions of the surgeon-lecturer.

A Division of Research and Industry, headed by H. Horton Sheldon, has been established at the **University of Miami** to expand and correlate all university

research and operate as a coordinating center. All research funds will be channeled through the division. Dr. Sheldon, industrial engineer who joined the Miami staff in 1946, is the inventor of the colorscope for electric color matching of textiles, codiscoverer of the actino electric effect, and discoverer of selective adsorption in charcoals.

An anti-icing research center has been established at the **University of Michigan** in the Engineering Research Institute. The Wright Air Development Center, a division of the USAF, is collaborating on the project, which will be under the direction of Myron Tribus, now on leave from the Department of Engineering, University of California at Los Angeles.

Northwestern University Medical School has appointed George M. Landau assistant professor of radiology and Lee G. Sewall associate in nervous and mental diseases. Fred Merrifield has been made associate professor of surgery, and the following have been made assistant professors: Reinhold Benesch (biochemistry), Nathan N. Crohn (surgery), Paul Szanto (pathology). George C. Turner has been promoted to associate in medicine.

An **Office of Scientific Research** has been established in the U. S. Air Force, and under the direction of Oliver G. Haywood, formerly of Los Alamos Scientific Laboratory, and Selby M. Skinner, of the AEC Chicago Operations Office, will sponsor graduate work in fluid mechanics, physics, chemistry, and mathematics. University and research organizations interested in cooperating with the Air Force in the program should address the OSR, P. O. Box 1395, Baltimore 3, Md.

The **U. S. Office of Education,** through a grant of $25,500 from the Association for the Aid of Crippled Children, will make a year's study of the qualifications and preparation of those needed to teach the nation's nearly 5 million school-age exceptional children, only about 15 per cent of whom are reported to be receiving special help. The study will be directed by Romaine Mackie, specialist, Schools for Physically Handicapped, with the assistance of a national committee of leaders in special education and an Office of Education policy committee.

The **Woods Hole Oceanographic Institution** research vessels *Atlantis* and *Albatross III* have set sail for a 15,000-mile, four-month investigation that will take them to Bermuda, Dakar, Recife, Barbados, and Trinidad, in a study of the equatorial currents between West Africa and South America. The coastal waters off West Africa have not been surveyed since the German *Meteor* expedition of 25 years ago. In all, the ships are expected to make 166 stations. Bostwick H. Ketchum will be in charge of the work on the *Atlantis*, and Francis A. Richards on the *Albatross III*. Ocean current investigations will be under the supervision of Frederick C. Fuglister and Columbus O'D. Iselin, Jr., who will join the expedition at Recife.

Grants and Fellowships

Applications for grants-in-aid for chemical research from the Cyrus M. Warren Fund of the **American Academy of Arts and Sciences** should be sent to the chairman of the committee, Frederick G. Keyes, MIT, Cambridge 39, Mass., by *Apr. 21.* Grants in excess of $300 are seldom made, and are generally for apparatus and supplies needed for research. No funds are awarded for salaries.

The **Army Quartermaster Division** has awarded $40,000 to the Department of Biochemistry at Northwestern University to extend investigations of edema and dehydration, in cooperation with the Research Service at Hines VA Hospital and the Army's Climatic Research Laboratory, Lawrence, Mass.

The **Commonwealth Fund of New York** has awarded a two-year annual grant of $22,500 to the University of Pennsylvania to implement its new "Doctor-in-Training" program (SCIENCE, **114,** 537 [1951]). Forty students are taking the course, which is administered by the Departments of Public Health and Preventive Medicine and Psychiatry, the university's hospital, and the hospital's Social Service Department.

The **Du Pont Company** has awarded 75 postgraduate fellowships to 47 universities and grants-in-aid to 15 universities for 1952–53, the latter for unrestricted use in the field of fundamental chemical research. By increasing its appropriation for such purposes to $510,000, the company has been able to contribute $15,000 per year to each of the 10 universities now receiving grants and to make new grants of $10,000 each to five others. In addition to the funds provided for fellowships, the company will pay the tuition of the fellows. Du Pont also continued its support of the Wallace Hume Carothers research professorship in chemistry, established at Harvard last year.

Massachusetts Institute of Technology is offering graduate and advanced research fellowships in electronics, sponsored by a group of industrial organizations. Stipends for graduate student fellowships range from $1500 to $2100, plus tuition, and advanced research fellowships range from $3000 upward. Application should be made at least four months prior to intended date of entrance, to the director, Research Laboratory of Electronics. A few research assistantships are also available in the Laboratory for students who wish to pursue a graduate program on a part-time basis.

The **National Paraplegia Foundation** will continue its postgraduate medical and pre- and postdoctorate basic science fellowships for research in spinal cord disease and trauma and in the commonly associated complications. The fellowships carry a minimum stipend of $3000 per year, and appointments will run for one, two, or three years, subject to renewal. Application forms, returnable before *May 1,* may be obtained from the chairman of the Medical Advisory Committee of the foundation, Broad-Grace Arcade, Richmond 19, Va.

The **National Research Council** Committee for Research in Problems of Sex will receive applications until *Mar. 15* for new grants-in-aid for the fiscal year beginning July 1. Blanks may be obtained from the Division of Medical Sciences, 2101 Constitution Ave., Washington 25, D. C. Inquiries should be addressed to the chairman of the committee, George W. Corner.

National Vitamin Foundation has awarded 11 new grants for research in vitamins and nutrition. In addition to this direct aid, the foundation has granted $800 to the Registry of Pathology of Nutritional Diseases, recently set up as a unit of the American Registry of Pathology of the Armed Forces Institute of Pathology, Washington.

The New York Academy of Medicine will award a grant-in-aid of $2000 under the Edward N. Gibbs Memorial Prize for original research in diseases of the kidney. Candidates must be physicians, resident in the U. S., who have been graduated at least three years. Evidence of research already performed and protocols of proposed research must be submitted with applications, which should be mailed prior to *Apr. 15* to Robert F. Loeb, Gibbs Prize Committee, Presbyterian Hospital, 622 W. 168th St., New York 32.

The U. S. **Ramsay Memorial Fellowship** for chemical research has been awarded to Margaret D. Cameron for study at the University of Leeds. This is a re-establishment, under the Fulbright Commission, of a fellowship that has been in abeyance since 1928. A British fellowship at University College, London, a Glasgow fellowship at the University of Cambridge, a Canadian fellowship at the University of Leeds, and two Spanish fellowships—at Oxford and Bristol—were also awarded.

Rockefeller Foundation grants for the last quarter of 1951 totaled $9,884,000, and General Education Board appropriations for the same quarter, $11,600,000. A Division of Natural Sciences and Agriculture, under the direction of Warren Weaver, will be created to provide a more widespread program in agriculture. J. G. Harrar, who has been in charge of agricultural field operations in Mexico and Colombia, was appointed deputy director for agriculture, with headquarters in New York. E. J. Wellhausen will be local director for the Mexican Agricultural Program, and L. W. Roberts will continue in a similar post in Colombia. In the social sciences, the foundation has given a capital fund of approximately $1,500,000 to the Social Science Research Council of New York, to be held intact by the council for ten years; $147,900 to Yale University for continuation of research on communication and attitude change, under the direction of Carl I. Hovland; two grants totaling $175,000 to Harvard University's Laboratory of Social Relations for the study of comparative cultural values and the physiological aspects of the development of behavior patterns. Foundation laboratories have been given $350,000 to extend investigations on insect-borne viruses and their relation to human disease. Other researchers in all parts of the world will receive assistance ranging from $300 to $200,000.

The **Williams-Waterman Fund** of the Research Corporation of New York has made a grant of $3,700 for the support of research in biochemistry at the University of Texas Medical Branch, Galveston, under the direction of John G. Bieri.

In the Laboratories

Kenneth C. Towe has been elected president of **American Cyanamid Company**, succeeding Raymond C. Gaugler, who died Jan. 11. Mr. Towe, who has been a director of the company since 1939 and a vice president since 1945, became associated with American Cyanamid in 1926. Edwin Kaleita, chemist, has joined the Biochemistry Research Department of the Lederle Laboratories Division, and Harriet H. Spagnoli, biologist, has been added to the viral and rickettsial research staff.

The **Borden Food Products Company**, a new unit of the Borden Company, has named Willis H. Gurley president. Vice presidents of the new division are Daniel M. Dent, George M. McCoy, Charles S. Strickler, and Sam Thompson.

William F. Clapp Laboratories, Inc., of Duxbury, Mass., have elected A. P. Richards president and director of the laboratories to succeed Dr. Clapp, who died on Dec. 28. Mr. Richards, formerly vice president, had been Dr. Clapp's principal assistant for 16 years in the extensive research in marine deterioration carried on by the laboratories.

Eastman Kodak Company has begun operations at its new chemical plant on the Sabine River, near Longview, Texas. Operated by the Texas Eastman Company, the plant will produce raw materials for the Tennessee Eastman Company, including ethanol and derivatives of *N*-butyraldehyde and isobutyraldehyde. Twenty-one of the projected 28 buildings on the Sabine site have been completed.

Plans for expansion at **Hercules Powder Company** include the construction of an $8,000,000 plant in the Delaware River industrial area for the production of phenol, *p*-cresol, and acetone. The new plant is scheduled for completion in 1953. Among personnel changes, Robert W. Lawrence has been named manager of explosives development to succeed C. H. Cordie, who recently retired; Donald H. Sheffield has been made assistant director of operations of the Naval Stores Department, and R. Stanley George, former associate technical director of the Experiment Station, will succeed him as manager of development; Peter Van Wyck will replace Dr. George, and Howard G. Tennent will replace Dr. Van Wyck as manager of the Experiment Station; P. Burke Welldon succeeds Dr. Tennent as manager of the Cellulose Products Research Division. At the Hercules pilot plant, Klamath Falls, Ore., opened in 1950 to study Western wood and its use in the wood naval stores industry, Lyle W. Rothenberger, formerly chief chemist,

has been appointed general superintendent, succeeding George E. Bosserdet, who has become manager of Georgia operations of the company's Naval Stores Department.

E. R. Squibb & Sons have created a Division of Engineering, to be headed by Bruce A. Hainsworth as director. Mr. Hainsworth, formerly district chief engineer of the H. K. Ferguson Company, Cleveland, will supervise the engineering and construction requirements of the parent company and its domestic and foreign subsidiaries.

United States Rubber Company has appointed Clayton F. Ruebensaal, formerly technical director, plastics and resins, for the Naugatuck Chemical division, commercial development manager, a newly created post. He will be succeeded by D. Lorin Schoene, formerly manager of organic research.

Meetings and Elections

The **American Association of Physical Anthropologists** will hold its annual meeting, sponsored by the Wenner-Gren Foundation and Hunter College, at the New York Academy of Sciences Mar. 21–23. E. Carl Sensenig, of the Medical College of Alabama, is organizing a symposium on the back, which will include presentations by clinicians as well as by human biologists. H. L. Shapiro, of the American Museum of Natural History, will discuss the Unesco Statement on Race at the annual dinner meeting.

"Recent Advances in the Study of the Venereal Diseases" will be the topic of the **Annual Venereal Disease Symposium** to be held May 1–2 in Washington under the auspices of the Experimental Therapeutics Study Section of the National Institutes of Health and the American Venereal Disease Association. Further information about the symposium, which is open to all interested persons, may be obtained from Frederick W. Appel, National Institutes of Health, Bethesda 14, Md., or from William L. Fleming, 750 Harrison Ave., Boston 18.

The **Association for Research in Nervous and Mental Disease** elected the following officers at its meeting in New York last December: president, H. Houston Merritt; vice presidents, Robert F. Loeb and Charles D. Aring; secretary-treasurer, Clarence C. Hare; and assistant secretary, Rollo J. Masselink.

A **Biostatistics Conference** will be held at Iowa State College June 16–July 25. Each day will begin with a lecture by a biologist on a problem that seems amenable to quantitative treatment and a lecture by a statistician on quantitative methods appropriate for such problems. Discussion sessions will be held later in the day. For details inquire of T. A. Bancroft, Statistics Department, Ames.

The **Committee for the Scientific Study of Religion,** recently organized by social scientists interested in the subject, is currently holding semiannual meetings at Harvard. At the fall meeting, Nov. 3, research papers and a round-table discussion were on the program. The spring meeting will be held Apr. 26. Qualified social scientists with empirical research to report may apply for places on future programs by writing, giving a full description of their work, to the chairman, Talcott Parsons, Department of Social Relations, Harvard. Inquiries about the organization and about membership should be directed to the secretary-treasurer, J. Paul Williams, Mount Holyoke College.

The **Ecological Society of America,** which met in Minneapolis last September, elected Frank C. Gates president, David E. Davis vice president, and Fred H. Test treasurer. Edsko J. Dyksterhuis was elected chairman of the Committee on Applied Ecology.

Officers elected by the **International Fat and Oil Commission** of the Union of Pure and Applied Chemistry during its meeting in New York last fall were: president, F. D. Snell (USA); vice president, H. Sturm (Switzerland); and secretary-treasurer, Jean Vizern (France). They will hold office until the meeting in Sweden in 1953.

Atlantic City will be the locale May 1–7 of the **International Foundry Congress and Show,** which is held every sixth year in this country. The International Committee of Foundry Technical Associations, representing England, France, Belgium, the Netherlands, Italy, Sweden, Switzerland, Spain, Denmark, Norway, India, and the U. S., expects 300 to 400 international visitors, and a two-week pre-meeting study tour of major foundry centers is being arranged for them. Presiding officers of the congress will be Walter L. Seelbach, as president of the American Foundrymen's Society, and Guido Vanzetti, Milan, as president of the International Committee.

The **Society for Experimental Stress Analysis** will hold its spring meeting in Indianapolis May 14–16. The society is an outgrowth of the Eastern Photoelastic Conference, and its interests now embrace also the measurement of strains and other mechanical quantities, stress analysis, and most other branches of engineering mechanics, with emphasis on application. Technical sessions of this first midwestern meeting will be held at the Lincoln Hotel, under the direction of J. M. MacLean, and a field trip through the Link Belt Manufacturing Company's plant is being arranged.

A **Symposium on Acoustics and Chemistry,** sponsored by the Office of Naval Research and Western Reserve University, will be held on the university campus May 21–23. Highlighted by a round-table discussion on possible applications of acoustics in chemistry, the program will consist of both invited review papers and contributed papers on original research. Those interested in contributing papers should submit abstracts of approximately 500 words *in duplicate* to Ernest Yeager, Department of Chemistry, Western Reserve, not later than *Mar. 21.* For other information concerning the symposium, address the director, ONR, 844 N. Rush St., Chicago 11.

Miscellaneous

The **American National Red Cross Blood Program** has available a fair-sized quantity of the following materials that are not suitable for clinical use but might be of interest to investigators in the fields of physical chemistry, biology, immunology, and related sciences: Human plasma protein Fraction I (fibrinogen) dried, as well as in the form of fibrin film and foam; Fraction II (γ-globulin) dried pyrogenic powder; Fraction III-2 (dried thrombin); Fraction IV-3,4 (α- and β-globulins) dried lipoproteins. These materials are available without charge and represent material surplus to the needs of the Blood Program. Requests for this material should be addressed to the Red Cross, Washington 13, D. C., immediately.

Point IV scientists have been sent to the following countries in the past few weeks: J. A. Monroe, entomologist, to Bolivia; William B. Mather, mineral technologist, and Fred A. Thompson, agricultural engineer, to Brazil; Harold Mowry, horticulturist, to Costa Rica; Arthur C. Kevorkian, fiber crop specialist, to Cuba; James R. Dawson, dairy husbandman, Woodrow W. Leake, agronomist, Hendrik Versluis, veterinarian, and Jay M. Hall, animal husbandman, to Iran; Cornelius C. Lewis, soils agronomist, and Charles E. Pegg, veterinarian, to Liberia.

The full text of the **Preliminary Program of the Research Committee on Synthetic Time Systems** has been approved by the Executive Board of the American Institute of Industrial Engineers, and the final program will be presented as a paper at the annual convention of the institute in Dayton, Ohio, May 10. The Research Program will be directed by V. D. Prian, industrial engineer and research scientist at the Lewis Flight Propulsion Laboratory.

The first issue of ***Public Health Reports,*** an expanded version of the weekly technical journal of the same name published since 1878 by the USPHS, appeared last month. Edward G. McGavran, dean of the School of Public Health, University of North Carolina, has been appointed chairman of the 12-member Board of Editors. The new monthly will incorporate two other PHS technical publications, the *Journal of Venereal Disease Information* and the *Communicable Disease Center Bulletin,* in addition to assuming the functions of the monthly *Tuberculosis Control Issues.* Howard Ennes is executive editor, and Taft S. Feiman managing editor.

Paul Rosenberg Associates, consulting physicists, formerly of New York City, have moved to new and larger quarters at 100 Stevens Ave., Mount Vernon, N. Y. Herbert A. Elion, project engineer, has recently been appointed to the research staff.

Recent Deaths

Chester S. Allen (70), of New York, civil engineer, Auburndale, Mass., Jan. 6; **Elmer R. Arn** (—), surgeon, Dayton, Dec. 24; **Harold S. Arnold** (74), bacteriologist, New Haven, Conn., Dec. 20; **M. Wilson Arthur** (61), electrical engineer, Jackson, Mich., Jan. 4; **W. Lloyd Aycock** (63), epidemiologist, Boston, Oct. 24; **William B. Bailey** (78), economist, West Hartford, Conn., Jan. 10; **Percy S. Barnhart** (—), naturalist, La Jolla, Calif., Dec. 23; **Oran C. Boyd, Sr.** (57), plant pathologist, Amherst, Mass., Jan. 5; **Clyde W. Brunson** (56), Navy Medical Corps officer, Des Moines, Dec. 20; **Gertrude S. Burlingham** (79), biologist, Winter Park, Fla., Jan. 11; **Arch I. Carson** (87), surgeon, Cincinnati, Dec. 20; **Ralph H. Chambers** (80), civil engineer, New York, Dec. 22; **Benjamin Chandlee** (54), clinician, Philadelphia, Jan. 6; **George P. Chittenden** (72), tropical fruit production expert, Costa Rica, Jan. 12; **William F. Clapp** (71), marine biologist, Duxbury, Mass., Dec. 28; **Walter W. Colpitts** (77), civil engineer, Princeton, N. J., Dec. 23; **Gerald A. Cowan** (49), mechanical engineer, Cincinnati, Jan. 8.

Lawrence H. Daingerfield (78), meteorologist, Beverly Hills, Calif., Jan. 6; **Harry S. Dolbey** (77), engineer and inventor, Warwick, R. I., Dec. 27; **Robert J. Fletcher** (60), chemist, Irvington, N. J., Jan. 1; **Cyril Sankey Fox** (65), geologist, Calcutta, Dec. 28; **Florence H. Frankel** (66), physician, Pinewald, N. J., Dec. 21; **Raymond C. Gaugler** (59), president, American Cyanamid Company, New Rochelle, N. Y., Jan. 11; **Malcolm M. Haring** (57), physical chemist, Dayton, Jan. 1; **Henri Hartmann** (91), surgeon, Paris, Jan. 2; **Charles Haydock** (64), engineer, Philadelphia, Aug. 31; **James R. Jack** (85), marine engineer and naval architect, Watertown, Mass., Jan. 6; **Walter L. G. Joerg** (66), cartographer and polar geographer, Washington, D. C., Jan. 7; **Foster Kennedy** (67), neurologist, New York, Jan. 7; **Tel Clarence Kimball** (58), mathematician, Trenton, N. J., Jan. 8.

Alberta A. La Pointe (60), inventor, West Hartford, Conn., Dec. 24; **Octa C. Leigh, Jr.** (45), surgeon, New York, Dec. 27; **Henry Link** (62), psychologist, Port Chester, N. Y., Jan. 9; **Floyd C. McDaniel** (65), eye, ear, nose, and throat specialist, New York, Dec. 31; **John M. McMillin** (68), mining engineer and oil firm executive, New York, Dec. 27; **Ralph E. Montonna** (57), chemical engineer, Minneapolis, Jan. 7; **George A. O'Donnell** (52), seismologist, Boston, Jan. 1; **Dallas B. Phemister** (69), surgeon, Chicago, Dec. 28; **George S. Pierson** (98), civil engineer, Kalamazoo, Mich., Dec. 30; **James A. Rafferty** (65), of New York, organic chemist, Fort Lauderdale, Fla., Dec. 19; **Arthur B. Ray** (62), chemist, Port Washington, N. Y., Dec. 24; **Elias A. Reed** (56), neurologist, New York, Dec. 27; **John J. Reilly** (39), physician, Brooklyn, Dec. 30; **Peter C. Reilly** (82), industrialist, Indianapolis, Jan. 4; **Josef W. Reutershan, Jr.** (62), automotive engineer, Passaic, N. J., Dec. 23; **Allen G. Ring** (37), technical librarian, St. Louis, Jan. 9; **Ira W. Rose** (71), pharmacist, Durham, N. C., Jan. 14.

Moses Salzer (70), internist, Cincinnati, Jan. 6; **Edwin W. Schreiber** (61), mathematician, Macomb, Ill., Dec. 18; **Alfred A. Schwartz** (60), otolaryngologist, New York, Jan. 13; **Augusta S. Slesinger** (79), psychoanalyst and welfare worker, New York, Jan. 6; **R. Gordon Smith** (64), chemist, Nyack, N. Y., Jan. 15; **John Stein** (80), astronomer, Rome, Dec. 27; **Albert I. Stiles** (68), industrial engineer, Summit, N. J., Dec. 28; **Charles C. Stillman** (74), social welfare administrator, Columbus, Ohio, Jan. 5; **Thomas W. Vaughan** (81), geologist, Washington, D. C., Jan. 16; **Walter H. Wright** (58), dental prosthesis specialist, New York, Dec. 31; **Zenon Zamora y Garcia** (56), surgeon, Vedado, Cuba, Jan. 8.

Technical Papers

Importance of Atmospheric Oxygen for Maintenance of the Optical Properties of the Human Cornea[1]

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It is well known that ordinary contact lenses interfere with the optical qualities of the cornea. This is evidenced by increasing haze in the vision and by diffraction phenomena (halos) about light sources. The changes are reversible and slowly disappear when the lenses are removed. In a study of the mechanism of these changes the fact that contact lenses prevent the access of the cornea to atmospheric oxygen was obvious.

To determine whether the cornea remains optically normal under relatively anaerobic conditions, four subjects were fitted with diving goggles in which the eyes could be exposed to various gas mixtures. The goggles were equipped with tubes through which the desired gas could be passed continuously and under slight pressure, so that all air in the goggle was quickly displaced and did not leak back in. The outlet tube from the goggle discharged under water.

The eyes were exposed for 4 hr to each of the following gases: (1) air, (2) air 85% and CO_2 15%, (3) N_2, (4) N_2 85% and CO_2 15%, all saturated with water vapor, and (5) relatively dry N_2. At intervals the subjects looked at a bright light source in a darkened room to discover whether halos, similar to those caused by contact lenses, had developed. All subjects had worn contact lenses previously and were familiar with such halos.

No halos were produced by exposing the cornea to moist air, or air-CO_2 mixtures for 4 hr, but bright halos developed in less than 2–3 hr in all four subjects when nitrogen was used. The subjects reported that, in addition to the appearance of the halos, their vision was "hazy" for a short time after the goggles were removed. Nitrogen-CO_2 mixtures produced halos similar in brightness to those obtained with N_2 alone. The halos produced with dry nitrogen, however, were not as bright as those obtained when water-saturated nitrogen was used. The halos observed in the experiments were similar in appearance, comparable in brightness, and of the same angular diameter as those caused by contact lenses.

If, as these data suggest, contact lens halos are caused by oxygen deficiency under the lens, they could be prevented by the addition of oxygen bubbles to the contact lens fluid. Contact lenses equipped with stoppered openings and fitted to the four subjects were found to cause definite halos in 1½ hr. Addition of N_2 bubbles to the contact lens fluid did not affect halo development, but the introduction of oxygen bubbles under the lens prevented the appearance of halos in experiments lasting 7 hr. During an experiment the bubbles became reduced in size, indicating that the cornea utilized the oxygen.

It is believed that the corneal haze and halos noted when contact lenses are worn are caused by hydration of the cornea, and that contact lenses interfere with the mechanism which maintains the cornea in its normal state of deturgescence. This mechanism may in part depend on the osmotic relations between the cornea and tears, but it is suggested that metabolic processes also are involved in the removal of water from the cornea.

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[1] This investigation was supported by a grant from the Office of the Surgeon General, USA.

Quaternary Volcanic Ash in Southern Alberta, Canada

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A 6-in. layer of volcanic ash occurs 6 ft below the surface in a 26-ft section of postglacial alluvial silts exposed along the east bluff of the Oldman River, 5 miles southeast of Monarch, Alberta (NW ¼, sec 26, T 9 N, R 23 W). The alluvial silts rest unconformably on proglacial lake deposits of glacial Lake Macleod (*1*), which existed as the ice retreated eastward during the Wisconsin Tazewell or Cary substage. The age of the ash thus appears to be Mankato or early postglacial.

The deposit is purplish-white in color and is composed largely of volcanic glass shards having an index of refraction of 1.507 ± 0.002. Below 1/16 mm the material is almost 100% volcanic glass, but above 1/16 mm there are abundant quartz, feldspar, and heavy mineral grains. Most of the grains are angular, but grains with well-developed crystal outlines also are present. The heavy minerals include brown hornblende—most abundant; common hornblende—abundant; hypersthene-enstatite—common; blue-green hornblende, zircon, apatite, and diopside—present; and basaltic hornblende, titanite, garnet, epidote, spodumene (?), and staurolite—rare. The variety of heavy minerals suggests that some contamination occurred during deposition. Mechanical analyses of the deposit fall within the range of loess analyses and confirm eolian deposition.

The indices indicate that the ash was derived from volcanics having an acid composition (*2*). Quaternary effusives to the west in southern British Columbia are a possible source.

The deposit is significant to geologists and archaeologists because it may provide a datum in correlating late glacial and postglacial deposits in an area along the probable migration route of ancient man into the interior of the continent.

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Attraction of Flies by Iso-Valeraldehyde

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Sporadic reports occur in the literature of compounds which act as specific attractants for various species of insects, but the physiological and behavioral bases of these actions are clearly understood in a few isolated cases only (*1*). The attractant reported here is of interest not merely because it adds another compound to the list but principally because it focuses attention upon a homologous series some members of which have recently been shown to possess qualities of attractiveness for insects. Furthermore, this series (the aliphatic aldehydes) already shows promise of serving as a useful tool for investigating the mechanism of action of attraction in much the same manner as the aliphatic alcohols have extended our knowledge of the mechanism of repellency (*2, 3*).

In the course of testing several hundred natural products and the extracts thereof as attractants for the flies *Musca domestica, Ophyra aenescens, Phormia regina,* and *Sarcophaga bullata,* it was found that of all materials tried a 10% aqueous solution of malt extract was the most attractive for the housefly and decayed casein the most attractive for *S. bullata.* The resemblance of the odor of certain fractions of these to that of iso-valeraldehyde suggested the desirability of testing that compound. Preliminary screening was accomplished by the use of Petri dish techniques (*4*). These consisted essentially of counting the numbers of caged flies attracted to various aqueous solutions of the aldehyde placed beneath the floor of the cage. Data from these experiments indicated that a 0.013*M* solution of iso-valeraldehyde was superior in its attraction of *Musca* and *Ophyra* to all other chemically defined materials heretofore tested.

This concentration is nearly equal to that which is repellent when acting as a stimulus to tarsal contact chemoreceptors. Stimulation of the tarsal receptors of the blowfly *P. regina,* for example, by a 0.028*M* solution of iso-valeraldehyde, even with the addition of 0.1*M* sucrose, causes rejection (*5*). Thus, although the present experiments indicate that the solution is an olfactory attractant, it would not be expected in the field to detain flies which had oriented to it unless an additional factor acceptable to tarsal and oral chemical senses was also present.

In order to determine the actual effective concentration in the gas phase, extensive tests were conducted by means of an olfactometric technique (Fig. 1) (*3*). Results to date show that the vapor concentration producing maximum attraction is approximately $1.2 \times 10^{-5}M$. Over the range $2.0 \times 10^{-5}M$ to $2.8 \times 10^{-5}M$ the aldehyde is partly attractive and partly repellent. This crossing-over phenomenon has been emphasized in the literature (*1*). Beyond $6.0 \times 10^{-5}M$ maximum repellency is obtained. Studies are continuing in order to determine the complete active concentration curve and to investigate the effectiveness of other homologs.

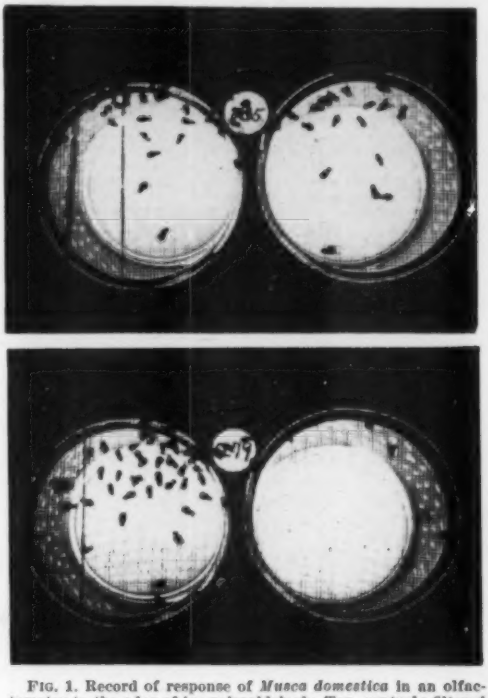

FIG. 1. Record of response of *Musca domestica* in an olfactometer to the odor of iso-valeraldehyde. Top, control: filtered air passing through both ports; bottom, experimental: iso-valeraldehyde vapor passing through left port.

As indicated above, other aldehydes have been reported as insect attractants. Those with short chains (up to 5 carbon atoms) attract codling moths and the Natal fruit fly, *Pterandrus rosa* (Ksh.) (*6, 7*). Palmitaldehyde is an effective attractant for cabbage looper moths, *Autographa* spp. (*8*). Recently it has been shown that acetaldehyde as a natural constituent of potato leaves directs the Colorado potato beetle in its selection of food (*9*). Whereas this case is apparently concerned with action on the gustatory sense, other aldehydes undoubtedly act through the agency of the olfactory sense.

The action of the various homologs listed here in attracting several species of insects which occupy rather widely different habitats suggests that naturally occurring aldehydes may comprise a class of compounds of some considerable importance in influencing the chemosensory behavior of insects.

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The Effect of Choleretic and of Hydrocholeretic Agents on Bile Flow and Bile Solids in the Isolated Perfused Liver[1]

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The mechanisms of bile formation and the factors controlling bile flow rates have hitherto been studied *in vivo* only; innervation, complex blood supply, variable oxygen tensions in the organ, and other factors that may influence bile secretion cannot be separated under those conditions. The development of an isolated liver preparation secreting bile for 12 hr or more (*1*) promises to greatly facilitate analysis of the physiology of bile secretion. The present communication is an example of the application of this preparation to the solution of a problem formulated but not resolved on the basis of studies in the intact animal.

Bile flow can be stimulated by various agents; prototypes of these are the conjugated bile acids on the one hand and oxidized unconjugated bile acids like dehydrocholanic acid on the other. The former (*2*) produces a marked increase of bile flow as well as bile concentration; the latter (*3*) produces an enhanced flow of bile with constant or diminished solid content. Drugs acting like dehydrocholates-hydrocholeretics, in dogs, cause marked increases in hepatic arterial, but not in total hepatic, blood flow (*4*). By contrast, choleretics like taurocholate cause no significant changes in hepatic circulation.

Is, then, the difference between choleresis and hydrocholeresis based on this circulatory effect, or is the circulatory effect secondary to a difference in response of the hepatic parenchyma to agents of these two groups? If hydrocholeresis as well as choleresis could be observed in the isolated organ, this preparation with its simple and controllable circulation should permit a resolution of the question raised.

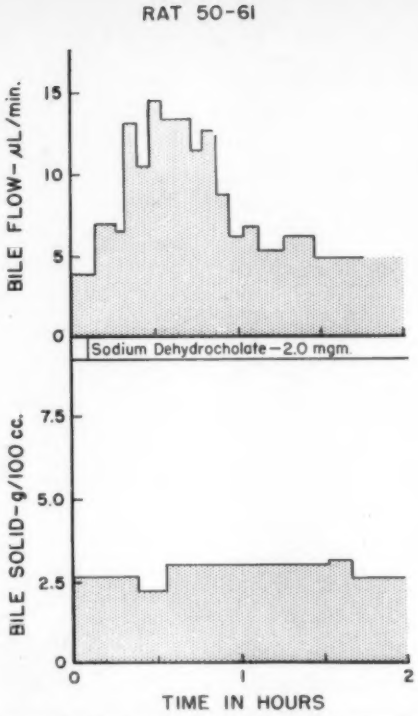

FIG. 1. Bile flow and bile solids after Na dehydrocholate. Rat liver perfusion 50-61, ♀, 280 g; 0 time—470 min perfusion. Perfusate flow = 73 ± 3 ml/min.

Livers of mature Sprague-Dawley rats were perfused as described in (*1*). Blood flow, bile flow, and bile total solids were determined (*1*). All studies were made during the steady bile flow phase of each preparation.

Conjugated bile salts were prepared from dog hepatic bile according to (*5*), recrystallized twice from alcohol-ether, and dried over silica gel. Sodium dehydrocholate (Procholon sodium, Squibb) was obtained in 20% solution; 2% solutions of both agents were used for injection.

Bile production by the isolated liver is readily affected by choleretic agents. In a series of 11 preparations the maximal increases in flow rates produced by injecting 2.0 mg sodium dehydrocholate averaged 250 ± 45%. For comparison, administration of the same dose to intact rats with bile fistulas resulted in a mean maximal increase of only 79 ± 17%. The administration of conjugated bile salts similarly caused increased bile flow rates (mean maximal increase after

[1] This work was supported by grants from the Division of Research Grants and Fellowships, USPHS, and the Division of Research and Medicine, U. S. Atomic Energy Commission.

[2] Present address: U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.

2.0 mg—120±15% above preinjection values—5 preparations). Time courses of bile flow after these two agents in typical experiments are shown in Figs. 1 and 2.

In a series of 16 preparations involving 35 injections, the total solid contents of bile before and after choleretics were determined on samples collected at 10-min intervals. Ten of these experiments involved the administration of dehydrocholate only (20 injections), 3 of bile salts only (5 injections), and 3 of bile salts and dehydrocholate administered in succession to the same preparation (5 injections of bile salts, 5 of decholin). Typical results of the experiments are represented in Figs. 1 and 2: choleresis induced by

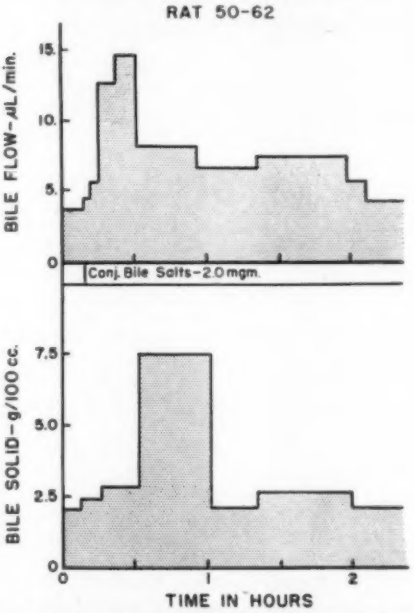

FIG. 2. Bile flow and bile solids after conjugated bile salts. Rat liver perfusion 50-62, ♀, 291 g, 0 time—240 min perfusion. Perfusate flow = 66 ± 3 ml/min.

dehydrocholate was accompanied by unchanged total solid concentration in 17 injections, and by decreased total solids in 8 injections; choleresis induced by conjugated bile salts was accompanied by pronounced increases in the total solid content of the bile in 9 out of 10 injections.

Perfusate flow through the liver, determined at 2-min intervals, showed no consistent changes following injections of either drug. The method employed was such that 10% changes in flow would have been detected.[3]

In the isolated liver preparation choleretic as well as hydrocholeretic effects can be elicited. In fact, the preparation responds more markedly than the intact animal, possibly as a result of bile salt depletion in the isolated circulation.

The parallel responses of isolated, perfused livers and of livers in intact animals justify application of the present results to the question raised originally. The isolated liver is perfused through the portal vein only; thus, changes in hepatic arterial blood flow cannot possibly occur. Since hydrocholeresis and choleresis are nonetheless clearly distinguishable in this preparation, a specific vascular response cannot be the basis of the difference in action between conjugated bile salts and dehydrocholic acid.

Again, total blood flow also remained unchanged in these experiments. Recalling that the blood supplied to the liver *in vitro* is saturated with oxygen—differing from that supplied in the intact animal—these facts lead to the following conclusion: If sufficient oxygen is supplied to the liver, choleresis as well as hydrocholeresis can be observed without accompanying changes in blood flow. Hence, differences between the two types of drug action depend upon some direct effect on the hepatic parenchyma, most likely on the hepatic cells.

[3] This has since been confirmed by using a continuously recording flowmeter, sensitive to fluctuations in flow of ±1%.

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The Purity of Crystalline Lactic Dehydrogenase

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In view of the results obtained by Theorell (*1, 2*) on the kinetics and mechanism of action of alcohol dehydrogenase, it seemed of interest to investigate lactic dehydrogenase in the same manner.

The lactic dehydrogenase investigated in the present study was Straub's (*3*) crystalline enzyme from heart muscle. Several preparations were made, and all gave the electrophoretic pattern shown in Fig. 1. This observation is the subject of the present communication.

In Fig. 1 two components are shown migrating to the anode, the major component having the greater velocity. Experiments in the pH range of 5–7 showed the two components to have a mobility difference of -0.8×10^{-5} cm^2 v^{-1} sec^{-1}. Electrophoresis was therefore used to obtain pure samples of each component. In 0.5 saturated ammonium sulfate solution the pure major component yielded crystals that appeared

[1] National Research Council fellow in the medical sciences. Present address: Department of Biochemistry, University of Wisconsin, Madison. The author is indebted to Hugo Theorell for interest and advice.

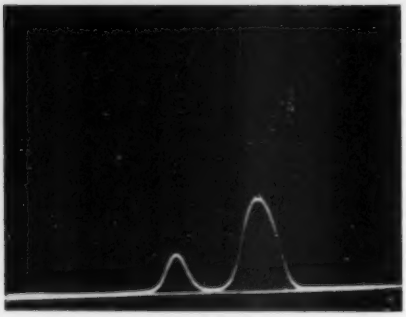

FIG. 1. The electrophoretic pattern of crystalline lactic dehydrogenase. Descending pattern in phosphate buffer pH 5.7, ionic strength 0.1. The salt boundary is just visible as a thickening of the base line on the extreme left.

identical with those in the unresolved enzyme or the crystals shown by Straub (*3*). This material migrated as a single component on electrophoresis. So far it has not been possible to crystallize the minor component.

The salting-out diagram, optical density at 280 mμ vs percentage saturation with ammonium sulfate, also shows a two-component system. The breaks in the salting-out curve are found at 40 and 43% ammonium sulfate saturation.

The activity of the enzyme was determined by measuring the rate of appearance of the absorption band of DPNH at 340 mμ. The tests were carried out in glycine-NaOH buffer, pH 9.6, with excess of DPN (*4*) and lactate. Both components were found to oxidize L(+) sodium lactate. The major component was usually somewhat more active on the basis of optical density at 280 mμ. D(−) sodium lactate was not attacked.

It seems to be an interesting fact that following the application of a rigorous test "pure" enzymes, like crystalline proteins, can often be shown to be heterogeneous. Different workers, using a variety of techniques, have provided evidence for different forms of pepsin (*5*), cytochrome *c* (*6*), ribonuclease (*7, 8*) and lysozyme (*9*). The study of such substances should aid in the elucidation of enzymatic reaction mechanisms, regardless of whether the different forms are present in nature.

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The Application of Electrophoresis-Convection in the Purification of Enzymes: Purification of the Alkaline Phosphatase of Swine Kidneys

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The separation of protein mixtures by electrophoresis-convection (*1*) has been quite successful, indicating that the application of this technique to the purification of enzymes should be explored. This note presents initial results of such a study in which a partially purified alkaline phosphatase preparation was the starting material.

The preparation of the alkaline phosphatase from swine kidneys and the determination of the enzyme activity were carried out as previously described (*2*). It was necessary to activate the enzyme before it was assayed. To do this, the final enzyme dilution was prepared in 0.01 *M* DL-alanine which was also 0.05 *M* in $NaHCO_3$-Na_2CO_3 buffer of a pH of 9.1. The diluted enzyme solution was incubated for 3 hr at 25° C to activate it and then assayed for enzyme activity. Total nitrogen determinations were made by the micro-Kjeldahl procedure.

Separations by electrophoresis-convection were carried out at 5° C, using a 0.1 ionic strength phosphate buffer at pH 7.2. The duration of the runs was 6 hr, and the field strength employed was 1.6 v/cm. When necessary, the protein solutions were concentrated by precipitation with $(NH_4)_2SO_4$ or acetone or by lyophilization, followed by dialysis of the enzyme against the phosphate buffer. This same phosphate buffer was used in the electrophoretic analyses.[2]

Table 1 presents the results obtained for a single-stage separation and in addition the final results for

TABLE 1

PURIFICATION OF SWINE KIDNEY ALKALINE PHOSPHATASE BY MEANS OF ELECTROPHORESIS-CONVECTION

Experiment	TPKU*	PU/mg TN†
1. Initial material	226	146
a. Fourth stage		
Top cut	12	392
Bottom cut	29	85
2. Initial material	250	191
a. First stage		
Top cut	95	270
Bottom cut	138	159
b. Fifth stage		
Top cut	15	588
Bottom cut	17	85

* TPKU = total phosphatase units × 10^{-6}.
† PU/mg TN = phosphatase units/mg total nitrogen.

[1] With the technical assistance of Eleanore D. Goodman.
[2] The electrophoretic analyses and mobility calculations were carried out by J. M. Vandenbelt and R. B. Scott, of Parke, Davis & Co. Their generous assistance is gratefully acknowledged.

a 4- and a 5-stage separation. The scheme used in these fractionations is essentially that suggested by Cann and Kirkwood (*3*) for the separation of the components of ovalbumin. A fifth-stage top cut contains the enzyme isolated in the top cell after 5 consecutive refractionations of the collected top cuts. The fifth-stage bottom cut represents 5 similar consecutive refractionations of collected bottom cuts. The enzyme not accounted for in Table 1 is contained in several fractions of intermediate purity. The purest preparation of renal alkaline phosphatase obtained (588 PU/mg TN) has three times the specific activity of the starting material, and appears to be about twice as active as the best preparations in the literature (*4*).

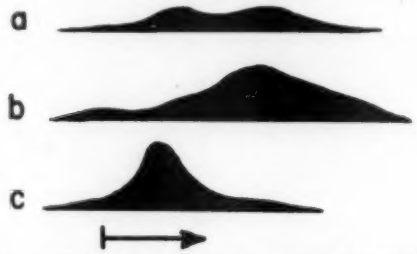

FIG. 1. Electrophoretic patterns (descending boundary). *a*, Expt 2, initial material; *b*, fifth-stage bottom cut; *c*, fifth-stage top cut.

Fig. 1 presents electrophoretic patterns for 3 of the fractions of the second experiment. Pattern *a*, the starting material for the fractionation, exhibits 2 peaks with respective mobilities of 2.2 and 5.0×10^{-5} cm^2/v sec. The broad nature of these peaks indicates the presence of more than 2 components. Pattern *b*, the fifth-stage bottom cut, is complex, but gives indications of components with mobilities of 2.2 (small amount), 4.0, 5.0, and 6.2×10^{-5} cm^2/v sec. The concentration of the more mobile components in this fraction is quite obvious from a comparison of Patterns *a* and *b*. Pattern *c*, the fifth-stage top cut, contains about 50% or more of what appears to be one component with a mobility of 1.7×10^{-5} cm^2/v sec. The presence of slower- and faster-moving components is also indicated. The use of different conditions in the electrophoretic analysis might show this fraction to be more complex than is indicated in the present pattern. However, the enrichment of this fraction in less mobile components is quite clear. The data do not permit conclusions as to the portion of the electrophoretic pattern which represents enzyme, except the obvious inference that it is contained in the slower-moving components of the starting material (*5*); hence no statements as to the absolute purity of the enzyme preparation obtained can be made.

It should be mentioned that the enzyme solutions employed in these fractionations were brown. The pigment, or pigments, responsible moved rapidly in the electrical field and were therefore concentrated quite efficiently in the bottom fractions. Consequently, the use of the Kirkwood apparatus for the removal of certain types of pigments from protein solutions is indicated.

A point of interest is that the present example is perhaps one of the least favorable that could have been chosen, since it was not possible to work at pH values near the isoelectric point of the enzyme. Much greater efficiency should be possible when enzymes that are stable in the region of their isoelectric points are employed.

The following points with respect to the use of electrophoresis-convection in enzyme purification are emphasized: (1) The yields of enzyme are practically quantitative. If the enzyme is sufficiently stable, the only losses that occur are mechanical. (2) The apparatus is much less expensive, and is better adapted for mass separations, than the Tiselius apparatus. (3) Although analytical electrophoresis equipment is of great value in orienting the course of fractionations in the Kirkwood apparatus, it is not essential when materials possessing measurable biological activity are being purified. Specific activity estimations of the fractions obtained are sufficient to guide the purification.

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Effect of Heparin on the Growth of a Transplantable Lymphosarcoma in Mice[1]

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It has been postulated that the gelation that occurs in mitosis prior to the formation of the spindle may have the same physical basis as the mechanism of blood clotting. Heilbrunn and Wilson (*1, 2*) have reported that heparin, in dilute solution, prevents premitotic gelation, thus inhibiting cell division. It was thought of interest to see whether this action of heparin would influence the growth of a rapidly dividing tissue, such as a tumor graft.

Mice of the inbred strain C3H/Jax and the lymphosarcoma 6C3HED were the test materials. The lymphosarcoma grows in 100% of the C3H/Jax mice, forming a discrete mass when transplanted subcutaneously. Fifteen male mice, 2 months old at the start of the experiment and of equivalent weight (approximately 25 g), were divided into three groups of 5 each. Groups 1 and 2 received intravenous injections of

[1] Supported in part by a grant-in-aid from the American Cancer Society, upon recommendation of the Committee on Growth of the National Research Council.

heparin every 12 hr. Group 1 received 5 USP units, and Group 2, 15 USP units per injection. The first dose of heparin was administered just prior to the subcutaneous inoculation of the tumor. Group 3, the untreated control, was inoculated with tumor at the same time as Groups 1 and 2. Inoculation of the tumor was made by trocar, under aseptic conditions. The course of tumor growth was followed by manual palpation. At the end of the seventh day, there were no differences in size of graft among the three groups. The tumors were large, and the animals debilitated.

Previous determinations of blood-clotting time in C3H/Jax mice showed the average normal time to be 49 sec. This increased to 7.8 min, 30 min after an injection of 5 USP units of heparin. Ten hr after the injection, the time dropped to 2.6 min. Blood samples taken 30 min after an injection of 10 units of heparin failed to clot 4½ hr later. Ten hr after the 10-unit dose, clotting time dropped to 1.8 min.

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Influence of Vitamin D on Deposition of Gallium in Bone of the Rat[1]

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Previous studies in various species have demonstrated that gallium and radiogallium (Ga^{72}), upon parenteral administration as the citrate, are rapidly and preferentially deposited in bone (*1–3*). Clinical studies of the isotope (Ga^{72}) have indicated that it may be useful in diagnostic procedures for the localization of osteogenic and metastatic bone lesions (*4*). To extend our understanding of the behavior of gallium in the normal processes of bone formation and repair, studies were made of the effect of vitamin D upon the deposition of this element in the bones of rats.

Preliminary studies indicated that the oral administration of vitamin D to rachitic rats and chicks, several days before the subcutaneous administration of Ga^{72}, resulted in an increased uptake of gallium by the bones when compared with the rachitic controls, which received no vitamin D.

After these preliminary findings, more detailed studies of rats were carried out. These were designed to show (*a*) effect of age and body weight on gallium uptake in the bones, (*b*) effect of vitamin D on the uptake of gallium in bones of animals raised and maintained on an adequate diet, and (*c*) the effect of vitamin D on deposition of gallium in the bones of rachitic rats.

The test animals were injected subcutaneously with gallium citrate containing 210–240 μc Ga^{72}/mg carrier Ga. The citrate complex (pH 6.5) was prepared as described previously (*5*). The concentration of the Ga^{72} was adjusted so that an injection of 1–2 ml was sufficient to give a dose of 400–600 μc Ga^{72}/kg body weight. The animals were killed 18–24 hr after subcutaneous injection, and the long bones of both hind legs were removed and cleaned free of muscle tissue. The bones were sectioned to separate the shaft from the end portions, and the resulting samples were placed in weighed planchets for radiochemical counting. Gamma counting was done by means of a shielded end window Geiger tube, using a 1750 mg/cm² adsorber to eliminate the β-particles and backscatter. A sufficient number of counts was made (in duplicate) to give a statistical accuracy of at least ±4%. All counts were calculated to the time of injection, allowing for decay time ($t\frac{1}{2} = 14.3$ hr).

A suitable aliquot of a standard sample of Ga^{72} was counted under the same conditions and used to calculate the quantity of Ga^{72} as μc/g dry bone. The initial standardization of this sample was by means of an ionization chamber meter, standardized against a known radium source (*3*).

After completion of counting, the planchets were dried at 110°–120° C for 16 hr, cooled, and weighed. The dried sample was then transferred to a weighed porcelain dish, heated to 1000° C, cooled, and again weighed, and the percentage ash in the dry bone was calculated.

Although efforts were made to standardize the conditions of feeding, sex, age, and weight of the animals of any one series, it must be emphasized that comparison of results of different series must be made with caution. The difference in the dose of Ga^{72}, differences in strain of animals, their age, and diet, are important factors that may contribute to differences between the series. Each series must therefore be considered essentially as a unit.

The series A albino rats were reared and maintained on a commercial diet (Purina Rat Chow), supplemented with fresh vegetables. The immature rats (108 g) were of the same stock as were the young adult animals (237 g).

The series B albino rats were young adults (205 g) of a different stock colony than series A. Littermates were selected at weaning and raised to maturity on an adequate diet. Five of these animals were fed (by stomach tube) 25 USP units of vitamin D daily for 4 days prior to administration of the gallium. The five littermates were given no vitamin D other than that contained in the basal diet.

Series C animals were rachitic rats. These rats were selected from two litters, so that each of the treated and untreated groups contained an equal number of animals from each litter. The young rats were maintained from time of weaning on a rachitogenic diet

[1] The opinions or conclusions contained in this report are those of the authors. They are not to be construed as necessarily reflecting the views or endorsement of the Navy Department.

consisting of yellow corn 76, wheat gluten 20, $CaCO_3$ 3, NaCl 1. Severe rickets was observed after 3–4 weeks on this ration. Fifty USP units of vitamin D was fed by mouth daily for 4 days before the administration of gallium. Healing of rickets was proceeding rapidly in the rats fed vitamin D, as evidenced by increased

TABLE 1

RADIOGALLIUM (Ga^{72}) CONTENT OF LONG BONES OF RATS 18–24 HR FOLLOWING SUBCUTANEOUS INJECTION OF GALLIUM (Ga^{72}) CITRATE

Treatment	Av body wt	No. of animals	Dose (mc/kg)	μc Ga^{72}/g dried bone		E/S† ratio
				Shaft	Ends	
Series A*						
Immature	108	5	.62	2.9	7.9	2.7
Adult	237	5	.56	2.6	7.1	2.7
Series B						
Adults	205	5	.46	1.4	3.8	2.7
Adults fed 100 units vitamin D	205	5	.46	1.4	3.6	2.6
Series C						
Rachitic rats	67	6	.56	3.7	5.3	1.4
Rachitic rats fed 200 units vitamin D	67	6	.56	3.9	7.5	1.9

* Albino rats. Series A of a different stock colony from series B and C.

† E/S ratio calculated from

$$\frac{Ga^{72} \text{ content of dried bone ends}}{Ga^{72} \text{ content of dried bone of shaft}}.$$

bone ash and by a line test performed (*6*) on a part of the group. Those not receiving vitamin D remained severely rachitic.

Table 1 gives a résumé of the results of the studies outlined above. In series A, in which the animals were maintained on a good commercial stock diet, the gallium deposition in immature and adult rats was found to be essentially the same. The small difference observed is readily accounted for by the difference in dosage. These results indicate that neither age nor body weight of rats is a significant factor influencing the amount of gallium deposited in the long bones of the rat.

The animals used in series B were maintained on a stock diet compounded to contain a minimal amount of vitamin D necessary for normal calcification and growth. Normal calcification was indicated in the bone ash data (not shown here). In these rats, the administration of a large supplemental dose of vitamin D over a 4-day period prior to the injection of gallium failed to influence the deposition of this element in bone.

The data presented for series C demonstrate that subcutaneously injected gallium is readily deposited in the bones of severely rachitic rats. It is noteworthy that this deposition of gallium has occurred in bones where there was little or no concurrent deposition of calcium salts as indicated by bone ash determinations.

A marked difference in the distribution of gallium laid down in rachitic bone compared with its deposition in normal bone is clear, first from the amount of gallium in the shaft of the rachitic bone and, second, from the ratio of the gallium in the ends of the bone to that in the shaft (E/S ratio). In experiments not detailed here, it was invariably observed that the gallium content of rachitic shafts was higher than that of the shafts of comparable normal control animals. In normal animals the E/S ratio is 2.6 to 2.7, whereas in the rachitic femur it falls to 1.4.

When vitamin D was administered to rachitic rats for 4 days prior to the gallium injection, calcification was observed both by line test and by increased bone ash. The increase in gallium content of the shafts of these bones, over that of the untreated controls, was small and of questionable significance, but the increase in the ends of the bones was greater than 40%. This resulted in an increased E/S ratio, approaching that of the normal animals.

Other studies were designed to test the usefulness of Ga^{72} as a tool in the bioassay of vitamin D. The results indicate that the quantitative estimation of radiogallium in the bones of rachitic rats is not a reliable or sensitive indication of vitamin D dosage.

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On the Mechanism of Formation of Higher Alcohols During Alcoholic Fermentation

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It has long been accepted that the higher aliphatic alcohol fraction, so-called fusel oil, present in yeast-fermented media is formed by deamination and decarboxylation of amino acids (*1, 2*). This has been referred to as the Ehrlich mechanism by Thorne (*3*). It was further pointed out by Ehrlich (*1*) and Neuberg and Hildescheimer (*4*) that a requirement for higher alcohol formation from amino acids by yeasts was the simultaneous conversion of appreciable amounts of sugar to ethanol. However, fusel oil is not formed during fermentation of sugar by cell-free yeast preparations (*5, 6*). Although the mechanism of the conversion of carbohydrates to ethanol has been intensively studied, the nature of the relationship between it, the Ehrlich mechanism, and other biochemical processes during alcoholic fermentation is not clear.

In the course of studies on the influence of various factors on fusel oil formation in alcoholic fermentation of grape juice, data were obtained on the relationship between the course of fusel oil formation, multiplication of yeast cells, amino acid utilization, and conversion of sugar to ethanol. These data shed some additional light on the mechanism of the formation of fusel oil. The results reported here were obtained during the course of fermentation of a 60-gal batch of grape juice heavily inoculated with a pure yeast culture. The juice was obtained from freshly picked, crushed, and pressed French Colombard grapes, a "white" variety of *Vitis vinifera*. The juice contained 24% reducing sugar, and had a pH of 3.5 when inoculated with starter yeast. The yeast employed was *Saccharomyces cerevisiae* var. *ellipsoidus* (Montrachet strain; No. 522 of the Enology Laboratory Collection). The juice was permitted to ferment at room temperature (approx 20° C), with mechanical stirring only at moments of sampling. During the fermentation the temperature rose from 19.5° to a maximum of 29.5° C, reached between the 60th and 70th hr after inoculation, 15–20 hr after yeast multiplication ceased, then fell slowly to 19.5° C, as conversion of sugar to ethanol was completed.

Samples were taken at intervals, after stirring sufficient to uniformly suspend the yeast cells. Fusel oil was determined by a modification of the method of Penniman *et al.* (*7*). Ethanol was determined according to the A.O.A.C. method for alcohols in wines (*8*). Yeast cell count was done by the direct haemacytometer method, using a Levy-Hausser counting chamber. Isoleucine, leucine, and valine naturally present in the juice were determined by microbiological assay.

The data are shown in Fig. 1. They are typical of other pilot-scale experimental fermentations, in which the same yeast strain and juice of the same grape variety were used, the results of which will be reported in detail elsewhere. The points to be noted in connection with Fig. 1 are as follows:

1) The amounts of the amino acids, isoleucine, leucine, and valine diminished rapidly to low levels within 18–37 hr after starting the fermentation and thereafter there were only slight changes, in general a slow, steady increase.

2) Yeast cell multiplication ceased between 45 and 50 hr after the fermentation was started, whereas formation of ethanol and fusel oil continued up to about 170 hr.

3) The course of fusel oil formation was concurrent with that of ethanol production, rather than with amino acid disappearance or yeast cell multiplication. Fusel oil formation was not noticeably interrupted by cessation of either amino acid disappearance or yeast cell multiplication.

4) The greater part of the total amount of fusel oil was formed after both rapid yeast cell multiplication and rapid loss of certain amino acids had ceased.

Calculations based on the data of Fig. 1 indicate discrepancies between the utilization of the three

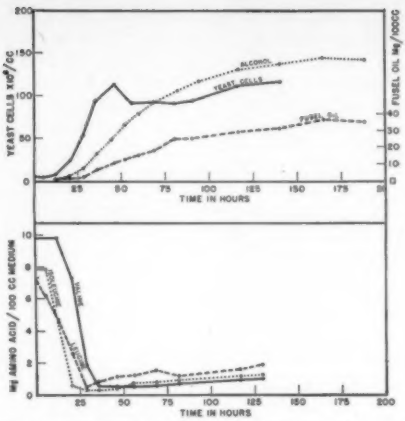

FIG. 1. The course of amino acid disappearance, yeast cell multiplication, and formation of ethanol and fusel oil during alcoholic fermentation of grape juice.

amino acids involved and the course of formation and final yield of fusel oil. At the point when the rapid decrease of valine, the last of the three amino acids to reach a low level, had ceased (37th hr), only about 34% of the theoretical yield of higher alcohols to be expected from them, if they had been completely transformed by the Ehrlich mechanism, had been formed. However, in the final stages of the fermentation, the amount of the higher alcohols found greatly exceeded the theoretical yield based upon the disappearance of the amino acids concerned. At the 168th hr the actual yield amounted to 255% of the theoretical. The calculations included only those higher alcohol components of fusel oil which could be formed from isoleucine, leucine, and valine by the Ehrlich mechanism. Analyses of the fusel oil fraction separated from grape wine by commercial distillation indicated that the major portion consists of these higher alcohols. Webb and Kepner (*9*) found recently that active amyl, isoamyl, and isobutyl alcohols account for about 88% of the higher alcohols of such a fusel oil sample.

It was previously assumed, on the basis of Ehrlich's work, and the subsequent interpretations of Neubauer and Fromherz (*2*), that deamination of amino acids furnished ammonia nitrogen for the synthesis of protein during yeast cell multiplication. In our experiments the failure of approximately equivalent amounts of the higher alcohol residues to appear concurrently with disappearance of their specific amino acid precursors might, at first sight, suggest that the Ehrlich mechanism was directly involved to only a slight extent in amino acid assimilation during yeast multiplication. The idea of direct assimilation by yeast of intact amino acids, earlier advanced by Thorne (*3*) on the basis of evidence not concerned with fusel oil formation could explain our findings. However, the later formation of large amounts of fusel oil is consistent with the idea of Ehrlich mechanism activity. Left un-

explained is the lag between apparent early deamination, incident to the rapid production of yeast protein, and the later appearance of the higher alcohols. This suggests that some intermediate steps between amino acid deamination and formation of the corresponding alcohols proceed more slowly than the earliest steps in assimilation. Neubauer and Fromherz (*2*) demonstrated that the most likely early intermediates were ketonic acids, and not hydroxy acids as previously supposed by Ehrlich (*1, 10*). These ketonic acids are later decarboxylated, according to Neubauer and Fromherz, to form aldehydes which are subsequently reduced to alcohols. These facts, together with the lag between amino acid assimilation and the appearance of fusel oil, the concurrence between ethanol and fusel oil formation, and the simultaneous cessation of both processes found in our experiments, suggest a simple explanation of the relationship between conversion of sugar to ethanol and the formation of fusel oil. It is likely that the final steps of both these metabolic processes make use of one or more identical enzyme systems. The slow appearance of the higher alcohols could be explained by competition between large amounts of sugar fermentation intermediates and small amounts of fusel oil intermediates, for the carboxylase and the hydrogen-transferring alcohol dehydrogenase-Coenzyme I systems of the zymase complex. When the supply of sugar fermentation intermediates which yield hydrogen to Coenzyme I failed because of the disappearance of sugar, the hydrogen transfer system could no longer reduce the aldehyde precursors of fusel oil components. Thus the formation of both ethanol and higher alcohols would simultaneously be terminated.

The appearance of the excess yield of fusel oil, which in our experiments greatly exceeded the theoretical yield based on the actual amount of leucine, isoleucine, and valine that disappeared, raised a question as to the source of precursors. A good possibility lies in the statements of Ehrlich (*1*) and Harden (*11*), that yeast can form fusel oil at the expense of its own protein when the extracellular supply of suitable organic nitrogenous nutrients is negligible. Freshly cultured yeast cells, when prevented from rapidly multiplying under conditions which still permit vigorous enzymatic activity, may be considered to be undergoing autolysis. Among the products of autolytic breakdown of yeast protein under such conditions there should be amounts of the specific amino acid precursors of fusel oil. There is some evidence for this in our experiments—namely, a measurable increase in the residual amounts of isoleucine, leucine, and valine in the medium during the stage of alcoholic fermentation subsequent to the cessation of rapid yeast multiplication (Fig. 1).

Other possibilities of accounting for the formation of fusel oil in excess of the theoretical yield have been considered, but such possibilities involve the abandonment of the Erhlich mechanism as a major factor in fusel oil formation. The writers prefer for the present to accept the Ehrlich mechanism, with the modifications suggested by Neubauer and Fromherz, as the source of fusel oil precursors, and the idea that the final steps are mediated by the carboxylase and hydrogen transfer systems of the zymase complex.

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Prevention of Postharvest Decay of Stone Fruits by Volatile Chemicals

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In-transit loss of peaches from disease is the limiting factor in the marketing of this crop. In spite of recommended field practices, brown rot losses in transit caused by *Monilinia fructicola* (Wint.) Honey[1] frequently exceed 10% of the crop value and greatly limit distribution.

In 1950, preliminary experiments were undertaken to investigate the possibility of using volatile chemicals to reduce the losses. Peaches and plums were inoculated artificially with a mixed spore suspension of *M. fructicola* and *Rhizopus* spp. These fruits were then incubated at 80° F and above 90% relative humidity for a 24-hr period prior to treatment with volatile chemicals. Replicated fruit samples were then placed in closed glass cylinders of 40-l capacity, inside of which the chemicals under test were introduced in open glass containers, permitting complete volatilization within the closed treatment chamber. After a 24-hr treatment period, the fruits were removed from the chemical atmosphere and were stored at laboratory temperature at a relatively high humidity for an additional period of 72 hr.

Trichloroethylene prevented all breakdown of the inoculated fruit and was effective at a concentration as low as 1:10,000 (1 vol nonvolatilized chemical in 10,000 vol atmos). No injury resulted to peaches and plums when exposed for 24 hr to concentrations of 1:4,000 and 1:10,000 of the chemical. Untreated con-

[1] In a recent publication (*Mycologia*, **37**, 648 [1945]), Whetzel recognizes the genus *Monilinia* Honey and thus treats this species as *Monilinia fructicola* (Wint.) Honey.

trol showed complete breakdown within this 5-day period.

Tetrachloroethylene and 1,1,2-trichloroethane also inhibited rot completely but caused some browning of the fruit at a concentration of 1:4,000 and less browning at 1:10,000. Observations suggest that much of this browning could be eliminated by circulating the atmosphere during the period of treatment, as the vapors apparently tend to stratify and settle to the bottom of the treatment containers.

S-tetrachloroethane inhibited all rot development completely at concentrations of 1:4,000 and 1:10,000 but also caused browning of the fruit. There is a possibility that lower concentrations of this chemical might be effective, since laboratory tests *in vitro* indicated that it will inhibit pure cultures of *Rhizopus* spp. and *M. fructicola* at concentrations as low as 1:20,000.

The above findings have been substantiated by pure culture toxicity tests in the laboratory with fungi as well as bacteria and are preliminary to more extensive studies now in progress on the evaluation of volatile chemicals as preventatives for market, storage, and in-transit losses to fruits and vegetables caused by microorganisms.

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Hemagglutinins in Caterpillar Bloods

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Although hemagglutinins are known to be present in a wide variety of animals and plants, their occurrence in insects does not appear to have been systematically investigated. During the course of experiments on the Cecropia moth, it was observed that the hemolymph of the larva and pupa of this species exhibits a relatively powerful agglutinating action when mixed with washed mammalian erythrocytes. The agglutinin was found to be present in titers of 1:25 to 1:625 in a large number of larvae and pupae examined, and appeared to be absent from the adult moth and from the egg.

The cecropial agglutinin is a labile substance, its titer being reduced by approximately one half upon heating the hemolymph, at pH 7.0, to 45° C for 1 hr, and by more than 97% at 55° C for 1 hr. It is largely or completely nondialyzable. No hemolysis occurred upon addition of guinea pig complement to mixtures of hemolymph and washed human erythrocytes.

It was of interest to examine other kinds of caterpillars for the presence or absence of hemagglutinin. To this end, specimens of hemolymph obtained from a total of 46 species of lepidopteran larvae,[1] representing 16 families, were tested for ability to agglutinate human erythrocytes. One one-hundredth ml of hemolymph was mixed with 0.04 ml 3% suspension of washed human erythrocytes obtained from a Group O donor. The mixtures were made in transparent glass spot plates, incubated at room temperature, and read at intervals up to 60 min.

The results (Table 1) show that hemagglutinins are present in 10 of the 46 species examined. All the species showing agglutinating action were moth larvae; all the butterfly larvae were negative. Beyond this, however, little correlation between presence of

TABLE 1

PRESENCE OR ABSENCE OF HEMAGGLUTININ IN HEMOLYMPH OF LEPIDOPTERAN LARVAE*

Heterocera		
Protoparce sexta	(8)†	0 to ++
Ceratomia undulosa	(1)	++
Cressonia juglandis	(5)	0
Callosamia promethea	(2)	0
Samia cecropia	(19)	+++
Actias luna	(3)	+ to +++
Telea polyphemus	(3)	0
Automeris io	(7)	0
Citheronia regalis	(8)	0
Dryocampa rubicunda	(4)	0
Anisota senatoria	(2)	0
Unidentified arctiid	(2)	0
" "	(1)	0
Euchaetias egle	(3)	0
Isia isabella	(1)	0
Halisidota tessellaris	(8)	+ to +++
Halisidota caryae	(9)	+++
Acronycta americana	(3)	0
Acronycta sp.	(1)	0
Unidentified noctuid	(1)	0
" "	(1)	0
" "	(1)	0
Symmerista albifrons	(3)	0
Datana ministra	(2)	0
Datana integgerima	(8)‡	0 to ++
Datana sp.	(3)	0
Hemerocampa leucostigma	(3)	0
Porthetria dispar	(2)	0
Malacosoma sp?	(2)	0
Sibine stimulae	(4)	+++
Prolimacodes badia	(2)	0
Phobetron pithecium	(1)	0
Unidentified cochlidiid	(1)	0
Galleria mellonella	(4)	0
Ephestia kuehniella	(1)	0
Unidentified cossid	(1)	+
" tortricid	(1)	0
" "	(1)	+++
Rhopalocera		
Danais plexippus	(3)	0
Polygonia interrogationis	(2)	0
Aglais antiopa	(2)	0
Papilio troilus	(3)	0
Papilio turnus	(1)	0
Papilio polyxenes	(1)	0
Pieris rapae	(1)	0
Epargyreus tityrus	(3)	0

* Figures indicate number of specimens of pools examined. Zero indicates no agglutination; +, barely visible agglutination; ++, erythrocytes in a great many small clumps; +++, a small number of large clumps; ++++, a single large clump.
† Seven specimens positive and 1 negative.
‡ Five specimens positive and 3 negative.

[1] We are greatly indebted to James King, The Biological Laboratory, Cold Spring Harbor, N. Y., for aid in identification of many of the larvae, to Pauline James and Patricia Moore for help in collecting, and to Alexander S. Wiener for supplying some of the human blood specimens.

TABLE 2

AGGLUTINABILITY OF A-, B-, AND O-ERYTHROCYTES BY HEMOLYMPHS OF *Samia cecropia*, *Halisidota caryae*, AND *Sibine stimulae*

Species from which hemolymph was obtained	Test erythrocytes	Final dilution of hemolymph							
		1:10	1:20	1:40	1:80	1:160	1:320	1:640	∞
Samia cecropia	A	++++	++++	++++	++++	+++	+	0	0
" "	B	++++	++++	++++	++++	+++	+	0	0
" "	O	++++	++++	++++	++++	+++	+	0	0
Halisidota caryae	A	0	0	0	0	0	0	0	0
" "	B	0	0	0	0	0	0	0	0
" "	O	+++	+	0	0	0	0	0	0
Sibine stimulae	A	++	0	0	0	0	0	0	0
" "	B	+	0	0	0	0	0	0	0
" "	O	+	0	0	0	0	0	0	0

agglutinins and taxonomic position is evident, hemagglutinins being present in larvae representing 7 different families. Although the origin and function of the agglutinating substances are not known, the possibility should not be overlooked that the agglutinins may be associated, in some species, with a state of parasitism, for all examples tested of *Protoparce sexta*, *Ceratomia undulosa*, and *Actias luna* contained hymenopteran or dipteran parasites. Information is lacking as to whether agglutinins are present in unparasitized examples of these species.

TABLE 3

SPECIFICITY OF AGGLUTININS OF *Halisidota tessellaris* AND *Halisidota caryae* FOR GROUP O CELLS

Test erythrocytes	Source of hemolymph			
	H. tessellaris,* Specimen No. 1	*H. tessellaris*,* Specimen No. 2	*H. caryae*,† Specimen No. 1	*H. caryae*,† Specimen No. 2
O, M, Rh_1	+++	++	+++	+
O, N, Rh_2	+	+	0	0
O, –, –‡	+++	++	++	+
A, MN, Rh_2	0	0	0	0
A, N, Rh_1	0	0	0	0
A, –, –	0	0	0	0
B, MN, rh	0	0	0	0
B, M, Rh_1	0	0	0	0
B, –, –	0	0	0	0

* Final dilution of hemolymph, 1:5.
† Final dilution of hemolymph, 1:10.
‡ Dash indicates M, N, or Rh character unknown.

Hemolymphs from some of the larvae listed in Table 1 were tested for agglutination of A- and B- as well as O-erythrocytes. The results (Table 2) indicate that *Samia cecropia* and *Sibine stimulae* agglutinins fail to differentiate the blood groups, but that *Halisidota caryae* agglutinin acts specifically on O-cells. Further evidence for the specificity of *H. caryae*, as well as of *H. tessellaris*, agglutinin is shown in Table 3. In an additional experiment in which 9 cell suspensions were prepared and coded by an assistant, the three O-suspensions among the 9 were correctly identified by use of *H. caryae* hemolymph. In a few instances, *H. caryae* hemolymph caused a relatively weak and delayed agglutination of A- and B-cells, owing apparently to heterozygosity or to antigen A_2.

Manuscript received September 24, 1951.

First Report of the Presence of a Dermatitis-Producing Marine Larval Schistosome in Hawaii[1,2]

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Marine snails, identified as *Littorina pintado* Wood, were collected from Moku Manu ('Bird Island'), near Kaneohe, Oahu, Hawaii, on Nov. 24, 1950, and were found to be infected with a species of larval schistosome. The degree of infection among the 40 specimens of *L. pintado* examined was 10%. Because of the difficulty in landing on this island, another bird refuge area known as Manana ('Rabbit') Island, offshore from Oahu, was later investigated. *L. pintado* (Fig. 1), collected from this locality at two different times (March and April 1951), was infected with the same species of marine larval schistosome at a rate of 0–5%, depending on the proximity of the snails to bird droppings washed down from the hillside where various species of marine birds nest. All the *L. pintado* snails containing schistosomes were found in tidal pools. Recent investigations (July 1951) on Mokulua Island, Oahu, indicate that *L. pintado* on the leeward side of this island was not infected with the schistosome, although many dark-rumped petrels (*Pterodroma phaeopygia sandwichensis* Ridgway) were nesting there at the time of investigation.

Penner (*1*) described a marine larval schistosome,

[1] Contribution No. 13, Hawaii Marine Laboratory.

[2] Acknowledgment is made to Wray Harris, marine malacologist, of the Bishop Museum, Honolulu, T. H., for the identification of the marine snails; to J. Donald Smith, game conservationist, of the Territorial Board of Agriculture and Forestry, Honolulu, for the identification of the bird specimens; and to John L. Pelgen and Charles E. Cutress, graduate assistants, of the Department of Zoology, University of Hawaii, for technical assistance.

FIG. 1. *Littorina pintado* Wood (Manana Island). Approx 3 × natural size.

Cercaria littorinalinae, from *L. planaxis* Philippi obtained from the Coronado Islands, in Mexico, and from Bird Rock, near La Jolla, Calif. Comparative measurements (as shown in Table 1) between *C.*

TABLE 1

COMPARISON OF MEASUREMENTS, BASED ON AN AVERAGE OF 50 SPECIMENS, OF THE SCHISTOSOME CERCARIAE FROM MANANA ISLAND AND THOSE REPORTED BY PENNER FOR *C. littorinalinae* PENNER 1950

	Schistosome cercariae from Manana Island (in mm)	*C. littorinalinae* Penner 1950 (in mm)
Length of body	0.248	0.271
Width of body	.091	.079
Length of head organ	.088	.060
Length of tail stem	.202	.288
Length of furca	.108	.157
Diameter of ventral sucker	.028	.023
Distance from ventral sucker to posterior end of body	0.086	0.083

littorinalinae Penner 1950 and the schistosome specimens obtained from Manana Island indicate similarity of the two forms, although there are variations in size. At present, a careful study of the internal anatomy of the schistosome cercariae from Manana Island has not revealed any differences in structure from those described by Penner. The Hawaiian marine larval schistosome has been identified tentatively as *C. littorinalinae* Penner 1950 until the adult stage is known (Fig. 2).

According to Richardson and Fisher (*2*), who made a survey of the birds on Moku Manu and Manana islands, there were six breeding species, three migrants, and eight visitants on Manana, and ten breeding species, three migrants, and four visitants on Moku Manu. In Penner's report previously mentioned,

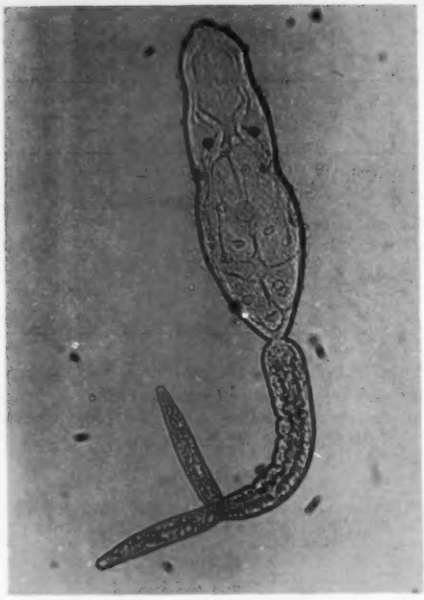

FIG. 2. *C. littorinalinae* Penner 1950 from *L. pintado* Wood. (Manana Island). Approx 210 × natural size.

the Wyman western gull (*Larus occidentalis wymani* Dicky and Van Rossem) was considered a possible natural definitive host, since adult schistosomes were observed in it. In view of the fact that the Wyman

FIG. 3. Dermatitis caused by marine schistosome cercariae, result of patch test.

western gull is not found in the Hawaiian area (*3*), the natural definitive host for the marine schistosome here remains unknown at present.

Although *L. picta* Philippi breeds in the same areas on Manana Island as does *L. pintado,* so far in thousands of snail examinations *L. picta* has not been found to be an intermediate host for this marine schistosome.

That this schistosome cercaria is capable of producing dermatitis in man is confirmed by experimental infection of human volunteers. Patch tests (made by placing in a piece of double-layer cotton gauze $2 \times 1\frac{1}{2}$ cms in size about 80–100 schistosome cercariae suspended in sea water) on the forearms of five volunteers showed that all individuals experienced the sensation of itching as a result of exposure. Two were observed to have typical schistosome dermatitis macules, with one person having as many as 17 lesions (Fig. 3); two developed erythema around the macules, lasting only a comparatively short time (6 and 12 hrs); and one individual did not develop a visible reaction. Controlled patch tests (made with sea water without schistosome cercariae) were all negative in these individuals.

"Swimmers' itch" in Hawaii was reported recently by Arnold and Bonnet (*4*). These cases of swimmers' itch, known locally as "Pearl Harbor itch," were most frequently observed in sea bathers in two areas—the West Loch of Pearl Harbor and certain sections of the Ala Wai drainage canal in Honolulu. Recent inquiries indicate that other widely separated areas on Oahu might be places where the Hawaiian swimmers' itch can be contracted. Sea bathers' eruptions, as reported by Sams (*5*) in Florida, appear to be similar to the Hawaiian swimmers' itch, although in both cases the cause has been attributed to an unknown agent. Investigations are proceeding to determine whether the Hawaiian marine schistosome is the causative agent of these dermatitis cases in man in Hawaii.

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Comments and Communications

Conditioning of the Palmaris brevis Muscle

In the spring of 1924 a fellow-student showed me how one could induce wrinkling of the skin of the ulnar side of the palm by direct pressure upon the ulnar nerve near the wrist just above and slightly lateral to the styloid process of the ulna. Such pressure causes contraction of the palmaris brevis muscle, with resulting wrinkling of the skin on the ulnar side of the palm.

As a teacher of anatomy I demonstrated this phenomenon to students and others over a period of some twenty years—I should say about 100 times—until in 1944 I noticed that, as I approached my thumb to press on the ulnar nerve, the wrinkling phenomenon occurred without my even touching the skin. Apparently I had conditioned the response to the subjective idea of pressure upon the nerve. Repeated experiments confirmed this, for even when I could not see my hand and did nothing more than think of producing the wrinkling, the response occurred.

The interesting thing about this conditioning is that I cannot produce it when my wrist is covered by the sleeve of a coat. The original stimuli were always given with the forearm bare. Another fact of interest is that the conditioning is entirely limited to the palmaris brevis of my left hand. Pressure was always applied to the ulnar nerve of the left forearm by the thumb of my right hand. Indeed, pressure upon the ulnar of my right forearm has elicited very poor responses and sometimes of the weakest kind. I have, in fact, rarely attempted such pressure, largely, I suppose, because I am right-handed and it is more convenient to use the right thumb in exerting such pressure.

The palmaris brevis response is easily elicited, and I have had difficulty in elicting it in very few persons. Those who may be interested in experimenting with this muscle will, perhaps, be assisted by the knowledge that even th gentlest stroking of the little finger may elicit the palmaris brevis response, and that in many cases even very slight movements of the little finger may produce it or a reasonable facsimile thereof.

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Indoxyl Acetate

In Science, November 30, 1951 (p. 579), Barrnett and Seligman mention the Pharmaceutical Laboratories of the National Aniline Division, Allied Chemical and Dye Corporation, as the source of chemicals used in the investigation. James J. McMahon calls attention to the fact that indoxyl acetate can be supplied, but sodium indoxyl alkali flux cannot, because of the hazards involved in shipment.—Editors.

Book Reviews

Fall of the Sparrow. Jay Williams. New York: Oxford Univ. Press, 1951. 158 pp. $3.00.

Every conservation-minded person will applaud this book, and every sportsman will want to join forces in avoiding needless destruction of wildlife. *Fall of the Sparrow* is, however, a book that should be read by everyone. It is easy reading, and in its discussion of the probable end of man it has strong appeal for the general reader. But the book does more. It not only tells in a very engaging way why species have vanished, but makes the reader aware of how many more are being threatened, including his own. Furthermore, there is an interesting account of many creatures now extinct, as well as entertaining comments on the origin of legendary animals. One soon becomes aware that behind Williams' humor there is much seriousness.

After reading past the first hundred pages and becoming distressed over the rate at which man has been ridding the earth of such animals as the dodo, auk, sea cow, etc., one is greatly gratified to come upon the next-to-the-last section dealing with "work on behalf of oppressed beasts, birds, and fish." Here Williams gives a worth-while history of control programs and current methods, including the International Union for Protection of Nature. Thus encouraged, one reads into the final chapter, only to become disturbed again because of the many minority human races that are disappearing as a result of man's meddling. The fate of the Tasmanians shows what "can happen when one human culture meets another. Just as man affects, usually adversely, the beasts with whom he suddenly comes in contact, so he also affects the members of his own species."

The writing is attractive, and each chapter has a full-page satiric drawing by Richard Taylor. All is done convincingly and is thought-provoking. The book is dedicated to the cahow, although this bird is not referred to in the text or in the index. Lack of inclusion of the cahow, an animal "extinct from 1621 to 1951 WHO BROUGHT HIMSELF BACK ALIVE," seems unfortunate, since not everyone sees *Natural History* magazine, where the recent rediscovery of this supposedly extinct form was announced (April 1951). Nevertheless, for so small a book this one is full of detailed information.

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The Housefly: Its Natural History, Medical Importance, and Control. Luther S. West. Ithaca, N. Y.: Comstock Pub., 1951. 584 pp. $7.50.

Like a new production of a favorite movie or classic stage play, Professor West's book presents anew a comprehensive treatment of an old subject—the housefly, *Musca domestica* Linn. And like many renewed theatrical productions, the new version surpasses the earlier and now out-of-print ones (by Howard in 1911, by Graham-Smith in 1914, and by Hewitt in 1914), both as to content and technical make-up. The newer knowledge concerning the fly itself, its natural history, and especially methods of control makes this modern account particularly needful and timely.

The thoroughness of the book's coverage is indicated by the inclusion of discussions on the fly's external and internal morphology, physiology, behavior, life history, taxonomy, distribution, ecology, parasites and microbiota, relation to disease and public health, usefulness as an experimental animal, and control, as well as a delineation of the field, museum, and laboratory techniques concerned in the study of the insect. The economic, medical, and public health aspects are given major emphasis. The three chapters on control include a discussion of recommended sanitary measures, as well as the uses and dangers of the new insecticides. An extensive bibliography adds to the book's value as a reference volume. According to the author:

> The book is intended primarily for the use of public health officers, Army and Navy medical personnel, experiment station workers, college and university staff members, and students of animal biology . . . [and, by the reduction of technical language to a minimum, for] all intelligent citizens who may be interested in natural history, sanitation, or public health.

The book is well written and well illustrated, except that more illustrations might have been used at a few pertinent points. Especially noteworthy are the refreshingly large, clear anatomical and morphological drawings used in the early chapters. The tabulation of detailed and bulky information is also excellently done, although an inconsistency is noticeable in the use of general or main headings on tables (for example, Tables 8, 9, and 10 and most others lack clear explanatory headings such as Tables 12, 13, and 14 have). Whether the author really intends the reader to consider the rickettsiae, viruses, and spirochetes associated with the housefly to be true "natural enemies" of this insect is not clear (p. 223), but such implication is to be questioned.

Except for a few peccadilloes of the type common to almost any first edition, the book in general is accurate, thorough, and authoritative. Furthermore, West has combined cold scientific data, a comprehensive review of the literature, pertinent historical background, and a warm, friendly style of writing in such a way as to come up with a scholarly, valuable, and practical treatise. An inviting format adds to the attractiveness of the book, making it one to be desired in the libraries of many biologists and public health workers.

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University of California, Berkeley

Soil Testing for Engineers. T. William Lambe. New York: Wiley; London: Chapman & Hall, 1951. 165 pp. $5.00.

Fourteen soil tests in common usage in soil mechanics laboratories are described in detail and discussed in this book. The text is meant primarily as a guide for student laboratories, but it will also be useful as a reference source to engineers and research workers concerned with the mechanical properties of soils and soil materials. The organization of the material, its pleasing reproduction, the excellent illustrations, and the appendices containing useful data and derivations of all formulas used in the main text are certainly a credit to the author. Unfortunate is the incidence of several undesirable colloquialisms and even grammatical lapses, which should not be found in a scientific book.

Each test is introduced with a short indication of its meaning and connection to field practices and behavior of soil *in situ*. These introductions are the least satisfying part of the book, which is probably more a matter of lack of knowledge about the mechanical behavior of soils than anything else. The reviewer, as a soil physicist, regrets that the author has not drawn on the vast source of information accumulated in the field of soil physics. This is particularly true for the sections on movement of water. Discussion of the energy concept of soil water, the idea of capillary potential, and a more detailed discussion of Darcy's law would have added to the value of this material. As a study text for students the book should be used with discretion and should be supplemented with discussion of other findings and theories than referred to in the text.

Missing, in a book with the purpose of teaching students how to measure soil properties and to distinguish on the basis thereof between different soils, is a discussion of the statistical treatment of the data. The question of adequate sampling is briefly mentioned but not with sufficient clarity. Anyone dealing with mixed populations (such as soils) should be familiarized with the fundamentals of the distinction between arbitrary classifications and with the essentials of estimating the proper number of samples and determinations on each sample. At least reference should be made to texts that consider the problem of interpretation of data containing unaccounted-for variation.

C. H. M. VAN BAVEL

Department of Agronomy
North Carolina State College of Agriculture and Engineering

Isoperimetric Inequalities in Mathematical Physics. G. Pólya and G. Szegö. Princeton, N. J.: Princeton Univ. Press, 1951. 279 pp. $3.00.

The classical "isoperimetric inequality" states that for any closed plane curve with given perimeter the area is not greater than the area of the circle with the same perimeter. There are many other interesting inequalities of a similar type concerning geometrical or physical quantities that depend on shape and size of curves or solids. Such inequalities are the subject of this book. The general aim is the possibility of estimating certain physical quantities, in which physicists or engineers are interested, by means of geometrical or other easily accessible quantities. Much work has been done in this direction during the past few decades and, in particular, the authors themselves had already made valuable contributions. In the present book a careful and systematic discussion and a well-organized presentation of these questions are given.

The first chapter (41 pp.) gives a lucid and readable summary of the definitions, methods, and results. Many of the results are given here in the form of comprehensive tables and at the end of the book. Chapter II discusses the principles of Dirichlet and Thomson, which in Chapters III and IV are applied to estimation of capacity C. Here the Dirichlet principle yields upper bounds for C, and the Thomson principle furnishes lower bounds for C. In Chapter V other methods (such as conformal mappings) are used for estimates of torsional rigidity and principal frequency, and in Chapter VI nearly circular and nearly spherical domains are discussed. Chapter VII contains diverse remarks of symmetrization, which is also discussed in the Notes A–F; Chapter VIII elaborates the cases of ellipsoids and lenses.

ARTHUR ROSENTHAL

Department of Mathematics
Purdue University

Linear Polymers. Elizabeth M. Frith and R. F. Tuckett. London–New York: Longmans, Green, 1951. 355 pp. $3.50.

The authors of this book have undertaken the difficult but necessary task of presenting the general physical chemistry of high polymers in a form suitable for a graduate in chemistry who intends to start research in the subject either in industry or at a university. And for such a person they have produced a valuable book. On occasion he might find the pace rather slow, for the authors adhere to the advice given to Alice, and start at the very beginning. A lengthy chapter is devoted to general principles of thermodynamics, for example, in which the whole content of an undergraduate's training in that subject is reviewed, and developed along lines leading to its application in the solution properties of amorphous polymers. Few readers would object to that. The authors have generously provided an account of the background they expect from the reader.

Although the particular subject of thermodynamics is well done, the authors are not uniformly successful in their treatment. Inevitably, when so many different subjects are dealt with, practical considerations of space will make it impossible to give a preliminary elementary discussion of each. Consequently, some readers may feel that too much time is spent in telling them what they already know, whereas other topics are introduced at an advanced level. Occasionally a subject is presented in so condensed a form, as in the

sections on the applications of x-rays to polymer chemistry, that it arouses admiration not so much for its usefulness as for its display of skill in packing so much into so little space. But the authors deserve praise for covering so wide a range with such dependable accuracy.

The emphasis of the book is on physical chemistry rather than on technology, and on a broad treatment of the subject rather than on a few topics of interest to specialists. It has apparently been the particular concern of the authors to relate the chemistry of high polymers to the classical physical chemistry of small molecules (as is explicit in the preface). If they succeed in doing that, they will remove for many the uncomfortable feeling that the arcana of high polymers constitute a science all their own.

The four years that have elapsed between the writing of the book and its publication have, in so rapidly developing a field, resulted in some gaps in the account. Even today, however, there is no other volume that answers the important purpose for which this one was written. As for the gaps, they can be taken care of by the use of recent review articles which, without the prior preparation given by this book, adopt too advanced a tone for most chemistry graduates.

SYDNEY ROSS

Department of Chemistry
Rensselaer Polytechnic Institute

Preparation of Organic Intermediates. David Allen Shirley. New York: Wiley; London: Chapman & Hall, 1951. 328 pp. $6.00.

This book is a compilation of procedures for the preparation of a variety of organic compounds. These procedures have been taken from readily available published literature. Confronted with these facts, it is of more than passing interest to examine the author's reasons for believing this compilation to be of value and in what fashion he has tried to avoid the shortcomings of similar compilations such as Vanino's *Handbuch*. These reasons are set out in a one-page preface. In view of its importance, it is unfortunate that the author did not devote more space and effort than this in an analysis of the problem.

The compounds included were selected on the basis of the following criteria:

(1) The compound either is not available commercially or if available is relatively expensive; (2) directions for preparation of the compound had not been included in *Organic Syntheses* through Volume 28; and (3) the compound is one whose structure is simple and contains reactive functional groups which make it useful as an intermediate, or its preparation involves a generally useful type of organic reaction and the directions may be applied to the preparation of related compounds.

In addition, the starting materials meet the following criteria:

(1) The material is available commercially at relatively low cost; (2) the preparation of the material has been given in *Organic Syntheses*; or (3) the preparation is given in another place in this book.

The following comments on these criteria occur to this reviewer. Although it is not so stated, a great many of these preparations involve safety hazards that would probably make them unacceptable for *Organic Syntheses*. In the text the author italicizes safety precautions in over 25 instances. Also, many of the preparations are so like those already given in *Organic Syntheses* for closely related compounds that they would probably never be included. Examples are the preparations of *p*-fluorobenzyl bromide, 6-methylquinoline, *n*-octadecyl iodide, *n*-valeronitrile, *p*-bromobenzoyl peroxide, and α-furil. There are many others.

In many instances, the reactions described are either lacking in novelty or strikingly similar to other preparations also included in the volume. Examples of the first type are the straightforward esterifications (pp. 148, 157, 162), the formation of acid chlorides using phosphorus trichloride (p. 156), the malonic ester synthesis (p. 154), and the preparation of an alkyl cyanide from an alkyl bromide (p. 298). Examples of the latter are the preparations of acrylyl (p. 3) and crotonyl chlorides (p. 89) from the corresponding acids by interchange with benzoyl chloride. Many other examples will be obvious to the reader.

This reviewer believes that the author has undertaken a task for which the expenditure of any conceivably rational effort is grossly disproportionate to the value of the results. In the face of this situation, the author has presented as commendable an account of his efforts as can be expected.

RICHARD H. WILEY

Department of Chemistry
University of Louisville

Scientific Book Register

The Theory of Atomic Spectra. Reissue. E. U. Condon and G. H. Shortley. New York: Cambridge Univ. Press, 1951. 441 pp. $11.00.

Statistical Design and Analysis of Experiments for Development Research. Donald Statler Villars. Dubuque, Iowa: Brown, 1951. 455 pp. $6.50.

Materials Technology for Electron Tubes. Walter H. Kohl. New York: Reinhold, 1951. 493 pp. $10.00.

The Black Carib of British Honduras. Viking Fund Publications in Anthropology, No. 17. Douglas MacRae Taylor. New York: Wenner-Gren Fdn., 1951. 176 pp.; 7 plates. $2.50.

Agricultural Chemistry: Practical Applications of Agricultural Chemistry, Vol. II. Donald E. H. Frear, Ed. New York: Van Nostrand, 1951. 588 pp. $9.50.

Vertebrate Sexual Cycles. W. S. Bullough. London: Methuen; New York: Wiley, 1951. 117 pp. $1.50.

The Temporomandibular Joint. Bernard G. Sarnat, Ed. Springfield, Ill.: Thomas, 1951. 148 pp. $4.75.

Les Conditions Ecologiques et le Peuplement des Vases d'Eau Douce. Encyclopedie Biogeographique et Ecologique, Vol. VI. Franklin Pierre. Paris: Paul Lechevalier, 1951. 104 pp.; 8 plates. 1800 fr.

Theory of Perfectly Plastic Solids. William Prager and Philip G. Hodge, Jr. New York: Wiley; London: Chapman & Hall, 1951. 264 pp. $5.50.

Handbook of Basic Microtechnique. Peter Gray. Philadelphia: Blakiston, 1952. 141 pp. $3.00.

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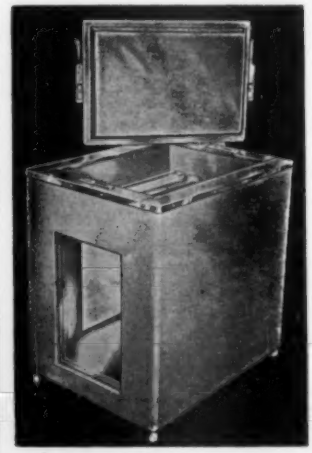

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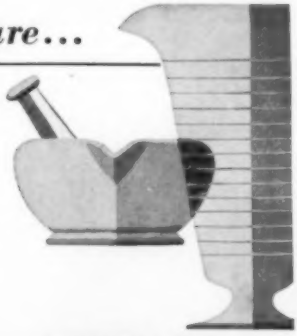

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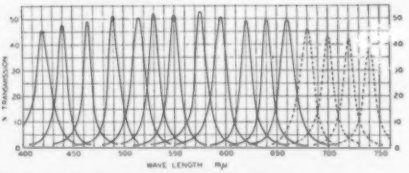

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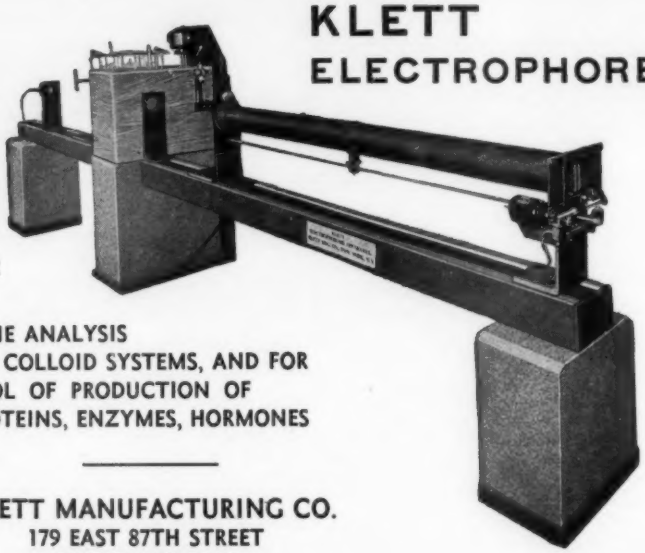

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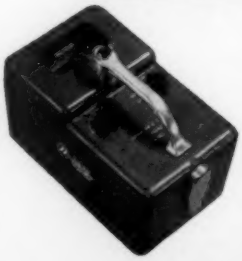

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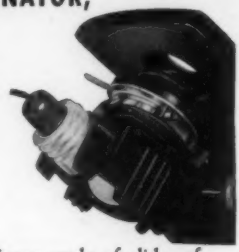

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